Enhancing safety performance in the construction Industry

-By Rohith Munnamgi

A qualitative comparison between Infrastructure and Oil & Gas projects on 43 roles in 3 pre-construction phases with perspectives from both clients and contractors.

by

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Preface

I started my journey at TU Delft having obtained a bachelor's degree and a small amount of work experience and with the hope of learning more about construction. However, the last three years in TU Delft gave me so much more through its engaging lecturers, its wide range of non-curricular activities and of course the master's thesis journey. There are a number of people that I need to thank that aided me in the completion of this journey.

First and foremost, I would like to thank my graduation committee: Prof dr.ir P.H.A.J.M van gelder, Assistant Prof. Karolien van Nunen, and Ir. Hans (J.P.G) Ramler for their unwavering support throughout this thesis. Around two months into the commencement of my research I had lost two of my three graduation committee members for various reasons but Pieter and Karolien gave me a new life by accepting to be my chair and first supervisor. From this point onwards their support in helping me research the topic I wanted to research has be second to none. To Hans Ramler, I am grateful for him to stay on board and trust that I will deliver some exiting research despite a number of changes in the research topic and in the graduation committee. Thank you for being the rock in my thesis journey and for supporting me through the entire one and half year.

A crucial element of this research was the semi-structured interviews and by conducting this research without any collaboration from an organization this was a difficult process. For accepting to do these interviews I would like to thank each and every interviewee for their participation. All of the interviewees participated merely due to an interest in the subject and shared insightful comments regarding the topic and shared their experiences regarding safety even though it is a sensitive topic to talk about.

To my friends in the Netherlands: Shivam, Pradeepthi, Sana, Likitha, and Mrinal thank you for all the support in each stage of this thesis journey. Their support was unwavering through the mental and physical challenges (you guys know what I am talking about) that this thesis journey put me through. Also thanks for all the fun and stress relief whenever needed, they really helped me enjoy the small wins through this process.

To my family, thank you for being my biggest source of energy and motivation in this journey. To my dad Mahesh, thank you for being an inspiration to get into this field and for the continuous conversations through which you impart a great deal of knowledge, it's like attending two universities at the same time. To my mum, Samrajyam for always caring more about me than anything else and for being there whenever I need you. To my younger brother Nihaar, for motivating in various stages of this journey and for constantly reminding me of my ability to deliver a great thesis report. I hope I have made you proud!

Executive Summary

The construction industry has been recognized as one of the most unsafe industries and represents high accident statistics. In the Netherlands it has been noted that in the year 2022, 129 accidents occurred per 100, 000 employees representing the second highest number only preceded by the waste management industry (Nederlandse Arbeidsinspectie, 2023). With the aim of improving this situation the research went on to first understand what safety performance is, and it was revealed that previously existing definitions by Hofmann et al. (2017) and (Griffin and Neal, 2000) have the tendency to blame workers. However, when a deeper look into the determinants of safety is taken it reveals a number of factors that can influence safety performance (Cornelissen et al., 2017). Cornelissen et al. (2017) further elaborates that one of the factors that has the ability to influence safety performance is client involvement and mentions that there is limited study on this aspect. It was further determined that the ability to influence safety performance gradually decreases as the project progresses but research reveals that majority of safety research focuses on the construction phase (Åsgård and Jørgensen, 2019);(Zhou et al., 2015). Lastly, Zhou et al. (2015) urges safety research in the construction industry to deviate from building projects and focus on other types of projects like Infrastructure and Oil & Gas. The combination of limited research on the role of client involvement to influence safety performance, limited research in the pre-construction phases, and the comparative element of introducing infrastructure and oil and gas projects forms the basis of this research and resulted in the following research questions, that are answered below:

What is the relationship between client involvement and safety performance on construction projects?

This question was answered by using a literature study to understand if client involvement can indeed improve safety performance and if so to understand how it can be done. Gibb et al. (2014) recognizes that as initiators of projects many decisions that clients make can impact safety performance, including allocating project budgets, setting project timelines, establishing project objectives and key performance indicators, contracting strategies, and project team members. Therefore it is important for clients to consider how safety performance can be improved in each of the decisions they make. Moreover, it was determined that construction projects in which clients actively participated in safety related-activities experienced a notable reduction in injuries (Kikwasi and Smallwood, 2016). Lastly, due to the fact that the ability to effect safety performance gradually decreases through the course of the project and because clients have the greatest leverage in the pre-construction phase, this phase was selected to further determine the roles that clients should execute to improve safety performance (Åsgård and Jørgensen, 2019).

What are recognized best practices for construction clients during pre-construction phases to improve safety performance?

Through the literature review this research revealed three key pre-construction phases: Planning, Inception, & Feasibility; Design; and Procurement & Tendering. A total of 43 client roles were found in these pre-construction phases where the Planning, Inception, & Feasibility phase had 12 client roles, the Design phase had 12 client roles, and the Procurement & Tendering phase had 19 client roles. A summary of these roles is presented in the Table 2.1.

What role do infrastructure and oil & gas clients play during the pre-construction phases to improve safety performance, from the perspective of clients and contractors?

From the roles determined in literature the research went into the semi-structured interview phase to reflect on the roles specifically in infrastructure and oil & gas projects. The perspectives of both clients are contractors was obtained on 43 different pre-construction phases of which 11 roles were further expanded in the later stages of this research. The reason for a specified focus on these roles is due to the different ways in which the different clients execute them. Meaning that either the particular role

was not conducted by one of the two clients or that it was executed differently by the two clients leading to insights into how these roles can be executed more efficiently. The first role that was expanded on is establishing a zero-injury objective, the different participants reflected on this role and it was determined that in deviation from literature that in fact clients should establish safety objectives that are stricter than zero-injury. An example of this is mentioned by oil and gas participants as establishing objectives based on near misses and incidents allowing clients to take a proactive approach towards safety. In addition to this another role that is reflected on in detail is the redefinition of the scope of the project based on the risk identification, to which practitioners mentioned that this is not conducted efficiently by clients because they do not involve contractors early on. Another important role that practitioners reflected on is identifying the safety specific issues from prior experience and similar projects. It was observed that on infrastructure projects this kind of knowledge sharing doesn't occur whereas on oil and gas projects it does occur but with a lack of transparency with the contractor. Along with identifying safety risks from prior projects it is also important to consult workers hired on on-going similar projects. It was seen that this does occur on oil and gas projects but not on infrastructure projects.

Moving into the design phase a significant role that was expanded on is to establish with all stakeholders the practices required for risk assessment and recording. Although, the different practitioners mentioned various ways of executing this role the research found a particular method mentioned by an oil and gas client effective. This method entails the evaluation of the client's and contractor's risk assessment processes and the selection of the the practices that are most strict. A fundamental safety role that the client should execute is the verification of whether safety of the future stages of construction are considered in the design phase. It was observed here that on infrastructure projects there exists limited number of safety experts to carry out this role. The lack of safety experts not only hinders this role but also restricts the development of hazard free designs considering the nature of the project. With the aim of establishing higher bars for safety it is the prerogative that clients introduce PtD and DfCS, in reflection of this practitioners mentioned that there is still hesitance from infrastructure contractors and design teams to implement this role. In the case of oil and gas projects these concepts seem to be taken into consideration but lack transparency in sharing this information to execution teams.

One of the key roles that clients need to play to execute a safe project is the selection of a safe contractor and to do so the client must include requirements in the tender documents to assess the tenderer's knowledge regarding safety. The interviews brought out a way in which this can be done effectively, which is to assess the tenderer's knowledge on the project by providing specific safety challenges and challenging the tenderer to address them. Another essential role that is mentioned in literature is addressing non-compliance to safety requirements by terminating the contract. However, it was observed that this is hardly done in practice due to the competency gap that exists between the client and contractor with each party blaming the other about low safety competency. Lastly, a vital client role before going into construction is discussing safety in detail during contract negotiation. In reflection of which almost all participants mentioned that the staff on site are completely different from those who execute the project leading to increased safety challenges during construction.

How can construction clients optimize their role during pre-construction phases of infrastructure and oil & gas projects to enhance safety performance? Having answered the sub-questions

it is important to attempt to answer the main question of this research. Considering the findings from literature, the interviews, and the expert validation it can be seen that construction clients can indeed improve safety performance on their projects by performing certain roles in the pre-construction phases. However, certain changes and optimizations need to be made, which can be seen below:

1. Establishing a zero-injury objective: Infrastructure clients can learn from Oil & Gas clients by establishing stricter safety objectives.
2. Risk assessment process: Clients on both types of projects can learn from literature and see the benefits of involving the contractor earlier in the project.
3. Knowledge Sharing: Infrastructure clients can learn from Oil & Gas clients about identifying, recording, and sharing of safety challenges faced on prior similar projects. However, both types of clients need to ensure the transfer of this knowledge to relevant stakeholders.

4. Considering safety of the future stages of the project during development of designs: Infrastructure clients can learn from Oil & Gas clients by including more safety specialists equipped to review whether designs take the future stages into consideration.
5. Including on-site workers in contract negotiations: the results reveled that both types of clients do not include on-site workers in the contract negotiation phase. This is something that they need to work on as the on-site workers will be the ones executing all the safety procedures.
6. Involving the contractor early on in the project: Contractors from both types of projects expressed their interest in being involved earlier in the project, allowing their expertise to be involved. Infrastructure clients recognize this and moving to contracting methods like two-phase contracting. Oil and Gas should also consider project delivery models that allow for this.

Nomenclature

Table 1: Abbreviations used in the report

Abbreviation	Description
OSHA	Occupational Health and Safety Administration
OHS	Occupational Health and Safety
RWS	Rijkswaterstaat
PtD	Prevention through Design
DCfS	Design for Construction Safety
INF	Infrastructure
O&G	Oil and Gas
MEAT	Most economically advantageous tender
HSE	Health, Safety, and Environment
PIF	Planning, Inception, and Feasibility
P&T	Procurement and Tendering
BOQ	Bill of Quantities
SMS	Safety Management System

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Introduction

1.1 Background Information

The examination of accidents and the field of safety science has been an ongoing topic of academic discussion, having seen significant development over the course of several years. The era during which significant emphasis was placed on occupational safety can be identified as the 20th century, as there is scarce documented evidence of prior concern for the well-being of workers in an occupational settings. However, a shift occurred in the United States following World War I, as the mining, steel, and manufacturing sectors experienced substantial growth (Swuste, 2013). During that period, the aforementioned industries exhibited accident and mortality rates that exceeded those observed during the civil warSwuste (2013). Professionals in these industries perceived accidents as an inherent aspect of their occupation or as a consequence of inadequate worker conduct, which in turn contributed to the presence of unsafe working conditions (Swuste, 2013). Moreover, the characterization of industries throughout this particular era was primarily centered around the objective of augmenting production levels and achieving cost-effectiveness. Consequently, this emphasis on productivity enhancement exerted heightened pressure on workers, ultimately leading to substandard safety conditions (Swuste, 2013). In 1906, US Steel implemented a nationwide Safety First initiative with the aim of altering the existing state of affairs (Palmer, 1926). In the United Kingdom, a comparable phenomenon took place, albeit with a distinct origin. Unlike in the aforementioned industries, where market actors spearheaded the effort, the government assumed the role of initiator(Swuste, 2013). Consequently, a number of reference books were developed to provide guidance on safety within these sectors.

These previously mentioned efforts resulted in multiple industries actively promoting the advancement of safety research and devising diverse methodologies and strategies to establish safer work conditions. The construction industry in the Netherlands is responsible for employing nearly 542, 000 employees and is responsible for around 193 billion euros of the Dutch GDP (Statista, 2020, Commission, 2020). Due to the large employment requirements and its contribution to the economy this research focuses on the construction industry. Consequently, it is necessary to get a concise comprehension of the historical context of safety-related research, with a particular emphasis on the advancements achieved in recent times. In their study, Patel and Amlani (2022) conducted a bibliometric and scientrometric analysis spanning the period from 2010 to 2019, with the aim of comprehending the research trajectory within the domain of construction safety. The authors of this study have identified several key research areas related to construction safety. These areas include Information and Communication Technology (ICT) in Safety Management, Workers' Safety Perception and Behaviour, Safety Management System, Hazard Identification, Accident Causation, Risk Management in Safety, and Safety Climate and Culture (Patel and Amlani, 2022). One recurring theme across these study subjects is the shared objective of enhancing safety performance and establishing secure working conditions for construction project personnel (Patel and Amlani, 2022).

It is vital to comprehend the notion of safety performance in order to undertake actions aimed at enhancing it within the context of construction projects. Numerous scholars have made efforts to establish a comprehensive definition of safety performance. In this regard, Dewi et al. (2020) have synthesized the widely acknowledged definitions proposed by Hofmann et al. (2017) and Griffin and Neal (2000). Their amalgamated definition characterizes safety performance as "a work behaviour performed by a worker to promote work safety at workplace through proactive and active work behaviour promoting safety at workplace to avoid work accident and injury" (Dewi et al., 2020). Deciphering the concept of safety performance further requires looking into it's components, Griffin and Neal (2000) acknowledge

that safety performance has two distinct elements, namely safety participation and safety compliance. According to Griffin and Neal (2000) safety compliance consists of “the core activities that need to be carried out by individuals to maintain workplace safety, including adhering to tagout and lockout procedures and wearing personal protective equipment”. On the other hand safety participation refers to “helping coworkers, promoting the safety program within the workplace, demonstrating initiative, and putting effort into improving safety in the workplace”(Griffin and Neal, 2000).

Furthermore, Hu et al. (2020) have also introduced the classification of safety compliance into two categories, namely ”deep compliance” and ”surface compliance,” drawing inspiration from the notions of deep acting and surface acting elucidated in emotional labor theory. According to Hu et al. (2020), the concept of deep compliance “refers to a form of safety compliance where individuals have the intention and strategy to complete tasks safely, actively monitoring for risks and taking appropriate actions to ensure safety”. On the other hand, surface compliance ”reflects a form of safety compliance where individuals aim to demonstrate compliance with safety rules and procedures without actively engaging in high-level cognitive activities necessary for desired safety outcomes” (Hu et al., 2020). Upon closer examination of the aforementioned definitions, it provides the impression that safety outcomes are achieved by individuals and doesn’t seem to amalgamate all aspects of safety performance. However, a more comprehensive exploration of the factors influencing safety performance presents a different perspective. Figure 1.1 illustrates this concept.

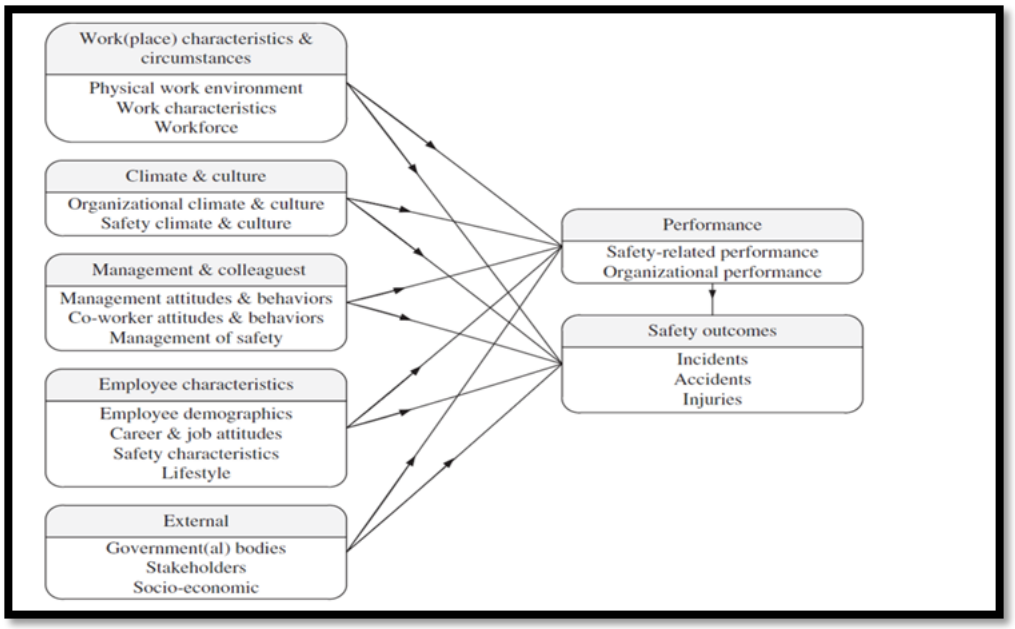

Figure 1.1: Determinants of safety performance from Cornelissen et al. (2017)

Figure 1.1 demonstrates that safety performance is impacted by a multitude of elements that extend beyond individual characteristics and behaviors of workers. Upon further examination of the aforementioned clusters, it can be seen that the cluster labeled as ”Work(place) Characteristics & Circumstances” encompasses variables pertaining to the physical and organizational elements of the work environment(Cornelissen et al., 2017). These variables encompass the physical environment, job demands, workload, and the policies and practices implemented by the organization (Cornelissen et al., 2017). This group of determinants has demonstrated that it can influence safety performance, more specifically the factors workload, time pressure, and the presence of hazards which have a detrimental effect on safety performance (Cornelissen et al., 2017). The next group of determinants, ”culture and climate” encompasses the examination of variables pertaining to the entire climate and culture inside an organization, with a specific focus on safetyCornelissen et al. (2017). This includes aspects such as leadership, communication, teamwork, and organizational values (Cornelissen et al., 2017). The study conducted by Cornelissen et al. (2017) has determined that there is a correlation between a positive safety atmosphere and culture and improved safety performance . The next group of determinants is

”Management and Colleagues” centers on the role of management and colleagues within the organizational , comprising elements such as leadership style, supervisor support, coworker relationships, and teamwork (Cornelissen et al., 2017). It was concluded in regards to this group of determinants that the establishment of positive connections with colleagues and the implementation of supportive management practices can significantly contribute to enhancing safety performance (Cornelissen et al., 2017). The group ”Employee Characteristics” investigates numerous factors such as employee demographics, job attitudes, safety characteristics, and lifestyle in order to get insights into the potential influence of employee characteristics on safety behaviors (Cornelissen et al., 2017). In regards to this group of determinants it has been noted that age significantly influences safety performance Cornelissen et al. (2017). However, the impact of gender and disabilities on safety performance remains unclear due to little study in this area (Cornelissen et al., 2017). The last group of determinants is the ”External” group which comprises several aspects beyond the organization’s boundaries. These components include government laws, stakeholder involvement, and socio-economic issues (Cornelissen et al., 2017). The findings from Cornelissen et al. (2017) reveal that there has been limited study conducted on the influence of external factors on safety performance.

1.2 Problem Statement

Before digging into the safety problems encountered with construction projects, it is imperative to comprehend the significance of enhancing the existing safety conditions within the industry. According to the National Safety Council of the United States, a study conducted in 2014 revealed that approximately 5% of the American workforce was employed in the construction industry but contributed to 20% of all fatal accidentsMisiurek and Misiurek (2017). Similar statistical trends were also observed in European countries, as reported by Grill and Nielsen (2019). In the Netherlands, where this research is focused, it has been noted that in the year 2022 129 accidents occur per 100,000 employees in the construction industry; which is a significant number compared to other sectors (Nederlandse Arbeidsinspectie, 2023).

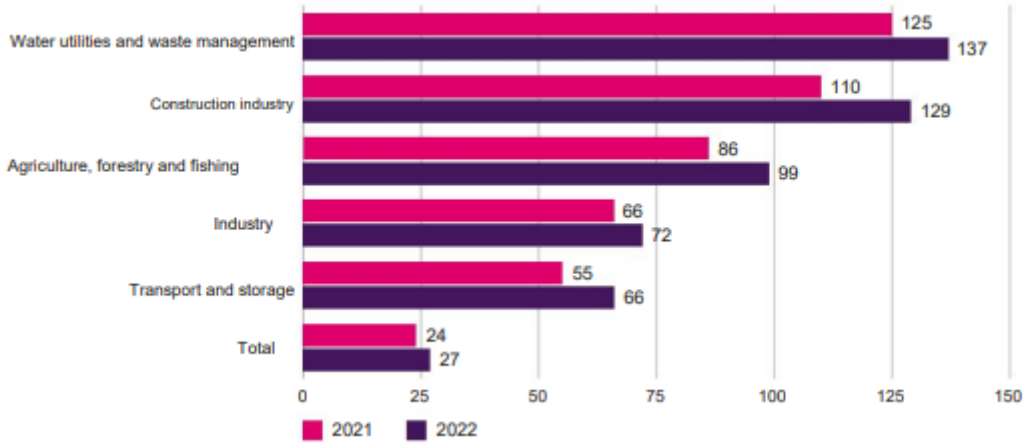

Figure 1.2: . Number of victims of occupational accidents per 100,000 employee jobs in 2022 and 2021 by sector (Nederlandse Arbeidsinspectie, 2023)

These high number of accidents in the construction sector in comparison to other sectors calls for the an improvement of safety performance in the construction industry. However, before this is explored it is imperative to examine the existing challenges that contribute to high accident rates within the construction sector. According to the findings of Ahamed and Mariappan (2023), the majority of accidents that take place on construction sites, amounting to 90 percent, may be attributed to human error. The researchers describe human error as the result of misjudgement and wrong decision-making within the cognitive process (Ahamed and Mariappan, 2023). Despite the aforementioned circumstances, it is crucial to acknowledge that this connotation seems to focus a lot on individual workers and can tend to blame workers for poor safety conditions (Ahamed and Mariappan, 2023). In order to shift the focus away from victim blaming, it is imperative to take into account additional variables that contribute to the

occurrence of accidents, such as deficient construction planning, insufficiencies in safety design, inadequate training in safety protocols, worker conduct, and limited familiarity with site regulations (Saeed, 2017).

Moreover, further research has been conducted to examine the barriers impeding the effective implementation of safety programs in the construction industry. Buniya et al. (2021) identify and emphasize four key impediments that provide significant challenges to advancement. The impediments encompassed in this study comprise an undesirable work environment, inadequate governance, insufficient safety knowledge, and industrial rules that lack supportive measures Buniya et al. (2021). Building upon the aforementioned barriers, a work environment that lacks support can present difficulties related to limited resources, inadequate commitment to Occupational Safety and Health (OSH), and the perception that safety is solely the responsibility of safety personnel (Buniya et al., 2021). Drawing upon the conceptualization depicted in Figure 1.1, it is seen that the hindrance labeled as ”unsupportive work environment” can be associated with various clusters identified by Cornelissen et al. (2017), such as deficient managerial attitudes and the safety attributes of personnel, which significantly influence safety performance. Insufficient safety consciousness spans various aspects, including inadequate training, low comprehension of safety threats and concerns, and a dearth of safety inspections. The hindrance labeled as ”Inadequate safety consciousness” can be associated with the safety determinate known as management of safety, as seen in figure 1. This hurdle has the potential to adversely impact safety performance. In their study, Buniya et al. (2021) discovered a notable hindrance within the realm of insufficient governance, specifically the lack of effective communication of safety norms and laws to all pertinent players involved in construction endeavors. The hindrance labeled as ”Inadequate governance” can be associated with the management of safety and client participation clusters, as seen in figure 1. This obstacle has the potential to affect safety performance. Finally, it is imperative to underscore the prevailing industrial practice that lacks adequate prioritization of safety in comparison to other objectives, such as time and cost (Buniya et al., 2021). This hurdle can be classified as a combination of external factors and climate & culture, as seen in figure 1.1. It pertains to the safety culture of the entire industry, rather than focusing solely on individual organizations, and has a significant influence on safety performance. Nevertheless, it is important to acknowledge that the improvement of safety performance can result in several advantageous consequences, such as increased worker job satisfaction, enhanced organizational commitment, improved job-related performance, and a reduction in employee withdrawal behaviors (Michael et al., 2005).

1.3 Research Gap

Looking back at the determinants of safety performance as depicted in Figure 1.1, it has been observed that the external component of safety performance has been limitedly studied, especially when it comes to the involvement of clients and other stakeholders like governments, regulatory bodies, consultants, etc. (Cornelissen et al., 2017). In regards to client involvement, it has been noted that the client's role in ensuring safety measures is often not clearly defined, with the responsibility typically falling on the contractor (Kikwasi and Smallwood, 2016). This phenomenon persists despite the acknowledgement that clients have a crucial role in fostering a culture of safety and establishing effective safety communication from the very beginning of a project (Ulang, 2012). The study conducted by Kikwasi and Smallwood (2016) indicates that the involvement of clients and their consultants in construction projects is typically restricted to activities such as inspection, provision of personal protective equipment (PPE), welfare facilities, and payment of insurance premiums. Despite the acknowledgement that the assumption of responsibility by clients has been empirically demonstrated to enhance safety performance (Shafiei, 2015).

Upon further examination it was determined that the ability to affect safety gradually decreases throughout the course of a project's life cycle and that the choices made during the stages prior to construction can influence on-site safety (Åsgård and Jørgensen, 2019). The figure by Szymberski (1997) illustrates how the capacity to impact safety diminishes during the course of the project life-cycle.

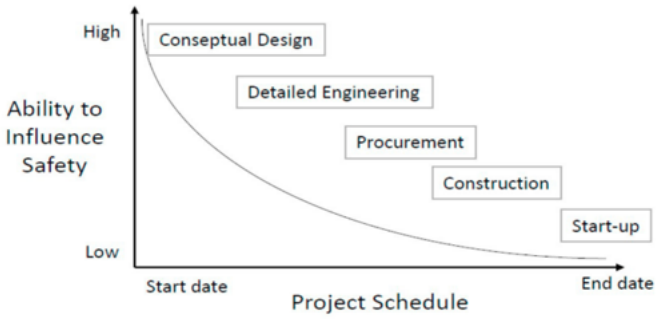

Figure 1.3: Changing ability to influence safety- Szymberski (1997)

In addition to this, it was concluded that clients have a crucial role to play in affecting safety performance during the pre-construction phase as it is the stage where his leverage is greatest and can in fact instil positive change, as the project progresses this leverage is shifted towards the contractor (Zhang et al., 2018). Moreover, it has been determined that the majority of research in regards to safety on construction sites has been conducted with a focus on the construction phase and limited research is executed in the pre-construction phases (Zhou et al., 2015), as can be depicted in the image below.

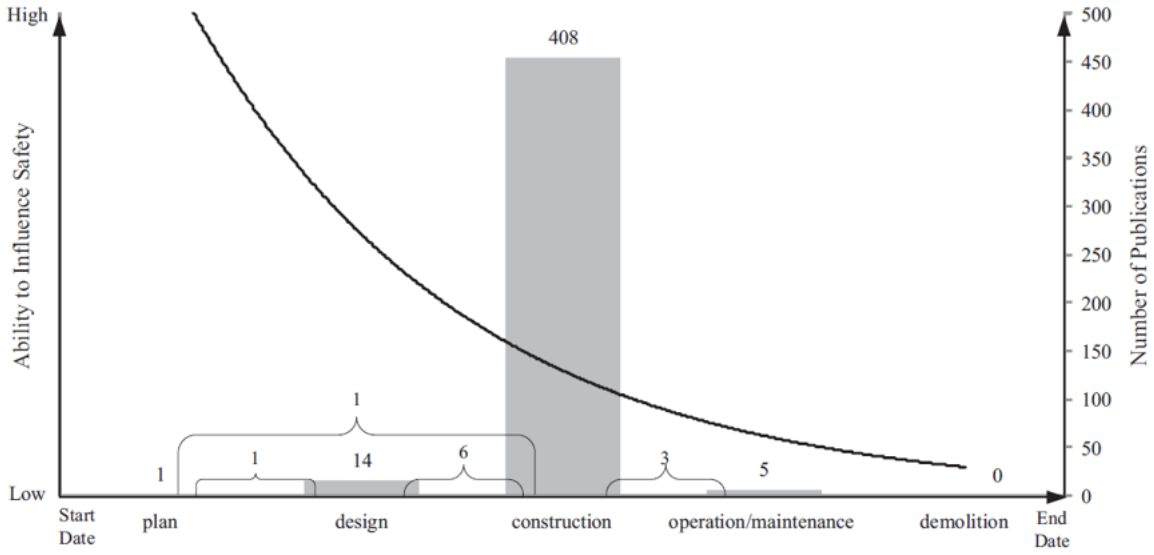

Figure 1.4: No. of publications distributed by project phase from 1978-2015 Zhou et al. (2015)

If this is indeed the case, it presents an exciting opportunity to explore what safety specific roles clients of construction projects should play and how they should portray them to reap the benefits from the early stages of the construction project.

Zhou et al. (2015) further reports in his research that majority of safety research on construction projects is focused on building projects and urges future researchers to investigate other types of projects like infrastructure and Oil & Gas projects. He makes this call due to the complex nature of these projects leading to an increase in construction risks (Zhou et al., 2015).

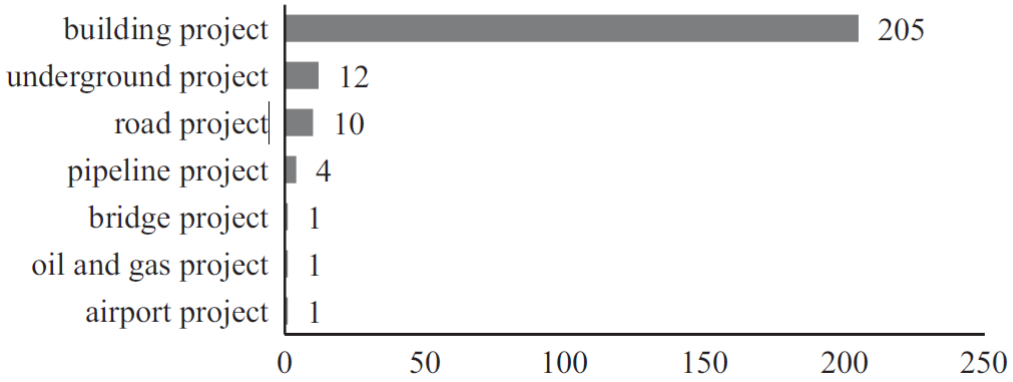

Figure 1.5: No. of publications distributed by project type from 1978-2015 Zhou et al. (2015)

Zhou et al. (2015) further elicits that the comparison of different types of projects can be beneficial in learning about safety performance, which this research is trying to do. The combination of limited exploration of the role of the client in improving safety performance, the limited exploration of safety during the pre-construction phases of construction projects, and the benefits of comparing two types of construction projects: infrastructure and oil and gas form the foundation of this research.

1.4 Research Objective

The primary objective of this study is to make a valuable contribution to existing research endeavours focused on enhancing safety performance within the realm of construction projects. The ultimate aim is to contribute towards reducing the number of incidents on construction projects. As previously said, there exist several aspects that can be impacted to enhance safety performance. However, this research will concentrate on external factors, with a particular emphasis on the role of clients in enhancing safety performance. The rationale behind choosing this particular component is attributed to the clients' duty in providing an environment for projects to achieve success in terms of productivity and safety. Furthermore, this research will employ a cross-project methodology to investigate the differences in the way clients execute their safety specific roles in the pre-construction phase of two project types: Infrastructure and Oil & Gas. The purpose of undertaking this endeavour is to get insights from both types of projects in order to recommend improvements to the safety specific roles that clients need to execute, in pre-construction phases, with the aim of enhancing safety performance.

1.5 Research scope

The field of construction safety management encompasses many different aspects, requiring the establishment of a narrow focus for an in-depth investigation within the time constraints of a master's thesis research. The focus of this research is scoped down in three distinct ways:

1. The research will focus on the specific region of the Netherlands, an important distinction to make because there different contextual factors that affect safety like legislation.
2. As mentioned earlier there are a number of factors that affect safety performance on construction projects, this research will focus on the specific factor of client involvement.
3. This research will focus on the pre-construction phases of a construction project.
4. This research will focus on clients from two different projects: Infrastructure projects and Oil & Gas projects.

1.6 Research Questions

How can construction clients optimize their roles during pre-construction phases of infrastructure projects and oil & gas projects to enhance safety performance?

In order to answer the main research question and to guide the research and its methodology the following sub-research questions have been formulated:
SRQ1: What is the relationship between client involvement and safety performance on construction projects?
SRQ2: What are recognized best practices for construction clients during pre-construction phases to improve safety performance?
SRQ3: What role do infrastructure and oil & gas clients play during the pre-construction phases to improve safety performance, from the perspective of clients and contractors?

2

Literature review

The first stage of this research will be a literature review, which will be used to understand the current state of safety performance on oil & gas and infrastructure projects, to gauge the different types of clients that take part in the two types of projects, and to answer sub-research questions 1 and 2. To further expand on the process, this stage will start with a keyword search of recognized safety-related academic journals to establish the background of safety on both type of projects.

The literature study will evolve into a more specific process to answer the sub-research question 1: ”What is the relationship between client involvement and safety performance”. To answer the question at hand a keyword search will be conducted using the words ”safety performance” and ”client involvement” in various academic search engines like Google Scholar and Scopus. The articles that are resulting from this search will be reviewed by reading their abstracts to identify relevant articles. This literature review aims to understand the role that client involvement can play in influencing safety performance.

Furthermore, the literature study will also help, answer the second sub-research question: ”What are recognized best practices for construction clients in during pre-construction phases to improve safety performance?”. To answer this question the keywords ”pre-construction” will be added to the aforementioned search, this is done to find articles that specifically articulate the activities that construction clients should undertake in the pre-construction phases to develop an environment where safety can thrive and to monitor safety throughout the execution of a project. Following a keyword search a snowball search was conducted utilizing the article by Raza et al. (2022). Since this article conducted a literature overview of the role of construction clients during the pre-construction phases it provided the opportunity to discover other relevant articles that could be suitable to this research. The aim here is not to understand how specific clients go about safety but rather to establish what any construction client should be doing in the aforementioned phases to support other stakeholders involved in construction projects towards improving safety performance. Having completed the literature review the objective is to have obtained an understanding of the type of clients on oil & gas and infrastructure projects in the Netherlands, to have understood the role that client involvement can have on influencing safety performance, and to have understood, for any construction client in general, what activities they should undergo in the pre-construction phases of projects to support other stakeholders in improving safety performance. The results of the literature review are presented in this chapter.

2.1 What is the relationship between client involvement and safety performance?

This section of the report will begin the literature study and will address the first sub-research question ”What is the relationship between client involvement and safety performance?”. To do so, this section will look into the safety regulation established in the Netherlands and what role is allocated to construction clients. It will further explore the main features of Oil & Gas and Infrastructure projects in the Netherlands, and how that effects client involvement in improving safety performance. Lastly, it will look at the current state of client involvement in safety on construction projects.

2.1.1 Safety Regulation in the Netherlands

The EU directive 92/57/EEC, implemented in 1992, sets out the minimum safety and health standards that must be followed at temporary or mobile construction sites. This directive was later incorporated into the working conditions decree, also known as Arbeiddsomstandighedenbesluit, in the Netherlands (Aires et al., 2010). Section 5 of the regulations pertains to the construction sector and specifically addresses the roles and responsibilities of three key parties: the client, the project supervisor, and the coordinator for health and safety (Human Environment and Transport Inspectorate, 2021). In this decree , the term client "means any natural person or legal person for who the work is being carried out"(Human Environment and Transport Inspectorate, 2021). The project supervisor "means any natural or legal person responsible for design and/or execution and/or supervision of the execution of a project, acting on behalf of the client"(Human Environment and Transport Inspectorate, 2021). The health and safety coordinator is a crucial part of the project's preparation and execution stages. They are defined as "any natural or legal person entrusted by the client and/or project supervisor, during preparation of the project design and during execution of the project"(Human Environment and Transport Inspectorate, 2021). In addition, the working decree mandates that the client must possess a comprehensive health and safety plan (Human Environment and Transport Inspectorate, 2021). This plan must clearly outline the necessary structure to be established, identify the coordinators responsible for each stage of the project, specify the hazards associated with the construction work, propose measures to minimise these risks, provide details on the implementation and supervision of these mitigation strategies, and outline the methods for communicating health and safety information and instructions to employees (Human Environment and Transport Inspectorate, 2021).

2.1.2 Overview of Oil & Gas and Infrastructure in the Netherlands

In this section of the report the important features of Oil & Gas projects will be highlighted including the stakeholders involved in such projects in the Netherlands, the characteristics of such projects and its affect on client involvement in safety.

The Dutch Oil & Gas Industry

Currently, the Netherlands is acknowledged as the foremost natural gas producer in Europe, primarily due to the Groningen gas field in the Northwest German Basin reaching its peak production in the late 1970s to early 1980s (GlobalData UK Ltd, 2022). Due to the presence of seismic risk and output limitations, the field has been deactivated in 2022 (GlobalData UK Ltd, 2022). The Dutch Oil and Gas business can be categorised based on geography into two groups: onshore and shallow-water. Onshore operations contribute the most to natural gas production, while shallow-water operations contribute the most to crude oil output (GlobalData UK Ltd, 2022). The primary crude oil and condensate production assets in the Netherlands are Schoonebeek (Olie), Sillimanite, F02A-HANZE, Rotterdam, and Q-13a-Amstel (GlobalData UK Ltd, 2022). The primary assets in the Netherlands for natural gas production are Groningen, K05a-D, A18-FA, and D12-B (GlobalData UK Ltd, 2022). The exploration and production business in the Netherlands is mostly controlled by many dominant organisations, including EBN BV, Exxon Mobile Corp, Royal Dutch Shell Plc, Neptune Energy Group Ltd, and Korea National Oil Corp (GlobalData UK Ltd, 2022). EBN BV, Exxon Mobil Corp, TotalEnergies SE, and Royal Dutch Shell Plc are the major contributors to natural gas production (GlobalData UK Ltd, 2022). In the context of this study, these organisations might be called clients or contracting authorities. They are responsible for defining the project requirements and engaging a contractor to fulfill those criteria.

The Dutch Infrastructure Industry

The Dutch Infrastructure industry is conventionally classified into three primary entities: the client, the architect, and the contractor. The client is responsible for commissioning, the architect for design, and the contractor for building (Bremer and Kok, 2000). The infrastructure industry is characterised by a highly fragmented market, with several small companies and a limited number of large companies competing (Bremer and Kok, 2000). Notable construction companies responsible for the majority of infrastructure projects in the Netherlands include Royal BAM group, Heijmans, Dura Vermeer, and

Belast Nedam. Regarding infrastructure clients, the main clients are Rijkswaterstaat, which is the national government agency responsible for carrying out public works and water management, including the construction and upkeep of waterways and roads. Additionally, municipalities play a significant role in public tendering activities for local and regional projects (Van De Rijt et al., 2010). The Dutch infrastructure projects encompass the development of roads, railways, locks, bridges, tunnels, and other related structures. Currently, the existing infrastructure is deteriorating, leading to a focus on renovating the existing infrastructure in most ongoing projects (TNO, n.d.).

2.1.3 Current state of client involvement in safety

The present condition of client participation in health and safety (H&S) programmes in the construction sector demonstrates a lack of motivation among construction clients to actively participate in safety initiatives (Musonda et al., 2013). In their study, Musonda et al. (2013) discovered that clients frequently assigned safety obligations to contractors as a result of their apprehensions regarding legal liabilities. Contractors retain the principal responsibility for the organisation and supervision of safety measures on construction sites(Musonda et al., 2013). Nevertheless, clients have progressively acknowledged that they are unable to separate themselves from legal responsibilities associated with workers' injuries(Musonda et al., 2013). The financial and reputational dangers associated with poor safety performance have been emphasised by factors such as prospective increases in worker's compensation insurance rates, higher settlements in lawsuits, and elevated OSHA fines for safety breaches (Musonda et al., 2013). Clients are voicing apprehensions regarding the fair distribution of safety responsibilities with contractors and are displaying an increased willingness to collaborate on safety issues(Musonda et al., 2013).

However, Raza et al. (2022) highlight insufficiencies in health and safety standards mandated by construction clients as a significant barrier to accident prevention. According to Åsgård and Jørgensen (2019), the researchers identify three primary reasons for this insufficiency: insufficient skills among individuals involved in the initial stages of the project, a lack of accountability resulting in shared responsibility, and clients' failure to prioritise or include health and safety requirements when soliciting bids from contractors due to their own lack of competence or prioritisation. This indicates an increasing acknowledgment among clients about the significance of safetyÅsgård and Jørgensen (2019). However, obstacles remain in converting this understanding into efficient and all-encompassing health and safety measures within the construction sectorÅsgård and Jørgensen (2019).

The impact of clients on safety performance becomes evident when examining the conventional roles they assume in building projects. Gibb et al. (2014) emphasise various responsibilities, such as allocating project budgets, setting project timelines, establishing project objectives based on employer's requirements and key performance indicators, selecting project delivery methods, contracting strategies, and project team members. These decisions can significantly impact safety performance during construction project execution(Gibb et al., 2014). Furthermore, as the instigators of projects, they possess the ability to establish stringent safety protocols for project execution, prioritising the well-being of their personnel from the outset(Lingard et al., 2020). This proactive approach significantly enhances the likelihood of attaining elevated safety levels (Lingard et al., 2020). Furthermore, it has been noted that construction clients have the most significant influence in shaping the perception, motivation, and behaviour of other stakeholders when it comes to safety(Said et al., 2009). This gives them the optimal ability to drive the necessary cultural shift for further enhancements in occupational health and safety (OHS) within the construction sector(Said et al., 2009, Wu et al., 2015) . Moreover, Vadsman (2006) determined that construction projects in which clients actively participated in safety-related activities experienced a notable reduction in occurrences and injuries. It is crucial to ensure that clients actively engage in safety-related activities as part of a team that includes the designer, contractor, consultant, and sub-contractors (Kikwasi and Smallwood, 2016)(Lingard et al., 2009). However, It is necessary for clients to avoid exerting excessive authority over contractors, as this can be perceived as excessive interference and a lack of trust (Lingard et al., 2020). Such behaviour can have negative consequences for any project. Therefore, it is important to strike a balance in implementing control measures (Lingard et al., 2020).

2.2 What are recognized to be the best practices for construction clients during pre-construction phases to improve safety performance?

In this section of the literature review the second sub-research question ”What are recognized to be the best practices for construction clients during pre-construction phases to improve safety performance?” will be answered. In this section the roles that are being identified are not specific to a particular type of project but rather a broad overview of the safety roles that clients should undertake in construction projects in general.

2.2.1 Planning, Inception, and Feasibility

This stage encompasses various activities, including initial budgeting, project briefing, logistical planning, selection of contractors and vendors, adherence to local planning authority guidelines, assessment of utility requirements, ground investigations and reconnaissance, compliance with health and safety regulations, obtaining necessary permissions, meeting designer requirements, and conducting structural assessments (Rao et al., 2016). This stage is essential as it is the sole phase in the construction process where everything is manageable and allows for making alterations and decisions without significantly impacting project budgets and timetables (Raza et al., 2022). It is crucial to emphasise that every component of the project must be thoroughly completed, without neglecting any details, as the consequences cannot be undone in subsequent stages of the construction process (Raza et al., 2022). The initial part of this process can be called the inception phase, during which the necessity of the project is explained and usually culminates in the creation of the project brief and objectives (Raza et al., 2022). At this stage, clients should prioritise safety by setting a ”zero-injury” goal for the project and consistently communicating this goal to relevant stakeholders as the project advances (Lopes, 2011).

After this stage, a feasibility study is carried out to ascertain if the project should proceed or not. During this stage, the identification and evaluation of risks play a crucial role. During this stage, it is common to prioritise risk assessment on factors that impact project expenses and deadlines, while overseeing health and safety risks (Toole et al., 2017). It is the responsibility of clients to ensure that such risks are incorporated into the risk assessment process (Toole et al., 2017). The client must identify the overall safety concerns specific to their project, taking into account the level of detail in the design (WorkSafe Victoria, 2017). Furthermore, it has been noted that engaging with different stakeholders might improve the identification of risks, as they contribute their specialised knowledge and skills (Fleming et al., 2007). The knowledge and experience of workers who have worked on comparable projects in the past should not be overlooked. They can be instrumental in recognising safety challenges that may arise in the current projects they are working on (WorkSafe Victoria, 2017, Ma, 2006). It is imperative to emphasise that merely identifying risks is insufficient; it is crucial to document these risks. This documentation can greatly benefit designers and contractors, enabling them to refer to and expand upon the risks identified by the client (WorkSafe Victoria, 2017). The risk assessment process may appear lengthy, but it can lead to a well-informed decision on whether to proceed with the project. It also allows for a re-evaluation of the project’s scope to eliminate safety issues and risks during the design phase, rather than relying on risk mitigation during the construction phase, where control is limited (Votano and Sunindijo, 2014).

Once the project is approved, the client must create the final project brief, project objectives, and design requirements. It is crucial for the client to clearly communicate safety specifications and standards, as they aim to prioritise safety performance as a key objective in all subsequent stages (Shafiei, 2015). At this point, clients start to concentrate on planning the next stages of the construction project. An important task here is to hire designers who prioritise safety. It has been noted that clients must play a crucial role in hiring safety-conscious designers in order to effectively assess risks and develop measures to address potential hazards that may arise during the execution phase (Toole et al., 2017). Alongside the recruitment of skilled designers, it is the client’s duty, at this stage, to assign their own resources to oversee safety during the project. A crucial aspect of this allocation is the formation of a safety team

for all construction phases, responsible for conducting regular inspections to ensure compliance with established safety standards (Ma, 2006). Lastly, the client must be ready for the tendering phase by determining the method via which they will convey their safety objectives to the tenderers (Toole et al., 2017).

2.2.2 Design

During this phase of the pre-construction process, the client's objectives from the previous stage are transformed into designs that can be implemented to create the final product. These designs undergo multiple iterations, starting from preliminary design to detailed design, and eventually culminating in the final designs. This process is crucial in order to prevent any design flaws or defects (Tayeh et al., 2019). The primary objective of this stage is to create a design that is safe, efficient, and capable of reducing or eliminating safety-related concerns (Raza et al., 2022). While it may be tempting to fully delegate responsibility to the design team at this phase, clients should actively assume several roles to consistently emphasise the significance of safety. The client's responsibility begins before the start of a project, as they must reflect on the safety issues encountered in previous projects in order to prevent the recurrence of mistakes in future designs (WorkSafe Victoria, 2017). It is essential for the client to perform reviews after each stage of the design process to address safety concerns and monitor any modifications made to the designs (WorkSafe Victoria, 2017). However, it is essential for the client to ensure that the design team adheres to the regulations established by regulatory organisations(Chunxiang, 2012). This not only guarantees the minimum safety standards but also facilitates prompt design approvals (Wu et al., 2015).

In addition to the minimal requirements, another important role that clients play in enhancing safety performance is their involvement in risk-related activities, particularly in conducting risk assessments from the beginning of the project(Raza et al., 2022). The initial step acknowledged by the clients is the issuance of comprehensive instructions to the design team to assess risks identified during the planning phase, identify any additional risks, and eliminate such risks via the design process (WorkSafe Victoria, 2017). Furthermore, the client must actively engage in collaboration and communication with essential parties to effectively resolve safety concerns(WorkSafe Victoria, 2017). The initial step involves the classification and subsequent distribution of risks according to the potential influence they may have on a stakeholder (WorkSafe Victoria, 2017). This offers the chance to subsequently schedule regular meetings with stakeholders to ascertain how the highlighted risks may be addressed in the design, fostering a collaborative endeavour among all essential stakeholders (Lingard et al., 2020). In order to maintain a collaborative process and demonstrate to stakeholders that safety is a primary objective for the client, it is crucial for the client to share their knowledge about risks and safety with all stakeholders(Abudayyeh et al., 2006). This will increase the likelihood of the risks being accurately taken into account in the designs (Abudayyeh et al., 2006). In order to effectively collaborate, the client should strive to create the necessary processes for risk assessment with stakeholdersAbudayyeh et al. (2006). Furthermore, it is important to document the risks associated with each construction activity during the later stages of the construction process (WorkSafe Victoria, 2017).

Prevention through design (PtD) and Design for construction safety (DfCS) are two strategies emphasised in literature for enhancing safety during the design phase of a construction process (Raza et al., 2022). These methods focus on the principle that during the design phase of a construction project, designers should prioritise and value the safety of the human resources employed at construction sites (Lingard and Wakefield, 2013). The underlying belief is that the most effective approach to preventing and managing safety risks is to eliminate hazardous components during the design stage (Lingard and Wakefield, 2013). The client can contribute to this process by setting higher safety standards through the application of Ptd and DfCS. This can be achieved by ensuring that designers address the constructability, use, and maintenance of facilities (Gambatese et al., 2005). Furthermore, research has shown that clients can actively contribute to the collaboration with designers by assisting in the selection of construction methods and gaining knowledge about site conditions (Votano and Sunindijo, 2014). This collaboration is essential in developing designs that are free from hazards and prevent the occurrence of risks in later stages of a construction project (Toole et al., 2017). The primary objective and duty of the client during this pre-construction phase is to create a definitive design that incorporates precise safety measures to address occupational health and safety (OHS) concerns, taking into

account the unique characteristics and scope of the project they intend to undertake (Chunxiang, 2012).

2.2.3 Procurement and Tendering

The final phase before construction begins is the tendering and procurement stage. Tendering refers to the process of developing and submitting a compliant offer to perform work for a specified price, so transforming the assessment into a bid (Patil et al., 2016). The essential tasks in this stage include the creation of tender documents, contractual documents, quality and quantity surveying, development of monitory systems, and preparation of work schedules (Rao et al., 2016). The primary duty of the client, and the initial phase in this process, is to prepare the tender for the project that the client intends to carry out. This allows the client to specify the desired level of safety performance to be achieved through the project. When preparing tender documents, it is crucial for clients to incorporate safety requirements. This allows clients to assess the tenderers' understanding of safety (Toole et al., 2017). These requirements serve as a foundation for selecting contractors and can be implemented through many methods, such as incorporating specific provisions that address safety measurement, such as safety performance figures (Votano and Sunindijo, 2014). Additionally, the client has the option to state, in the tender documents, that tenderers must provide a safety plan and provide specific details about the construction methods, including an emergency plan (Kikwasi, 2008, Ma, 2006). The client can emphasise the significance of following safety standards in the tender documents by incorporating a clause in the contract stating that failure to comply may result in contract termination (Chunxiang, 2012)). Another method for the client to demonstrate the importance of safety in the tender documents is by explicitly making safety part of the project cost estimate that consultants and contractors have to address(Abudayyeh et al., 2006). This allows for the evaluation of whether the tenderers are allocating sufficient expenditure towards safety measures (Abudayyeh et al., 2006). In addition, the client can enhance safety awareness by including the safety-related legislative documents in the tender documents. This will ensure that the implementation and enforcement of safety regulations are emphasised Zuofa and Ocheing (2017). Lastly, it is vital for the client to provide detailed information regarding safety matters in the tender documents, as they contain critical information about all parts of the project. This should be done with the same level of importance as other items (Ma, 2006).

Once the client has created the tender documents, it is necessary to ask potential bidders to submit their bids for the project. Within the Dutch/European framework, this phase is split into two distinct stages: evaluation of the bidder and evaluation of the bid (Chao-Duivis et al., 2013). The evaluation of the tenderer is carried out using selection criteria, which comprises assessing the suitability and capability of the tenderers to fulfil the contract that will be granted at the conclusion of the procurement process ((Chao-Duivis et al., 2013). The selection criteria should focus on evaluating the bidder's qualifications rather than the specific methods they will use to carry out the project (Chao-Duivis et al., 2013). In this case, the client can include a criterion to evaluate the bidder's past safety performance by considering their total recordable injury rate (TRIR) on previous projects they have completed(Zuofa and Ocheing, 2017). Another criterion that can be employed to emphasise the significance of safety is evaluating the financial viability of the bidder who is knowledgeable about safety measures (Ma, 2006). Engaging in this selection process allows clients to minimise the pool of potential bidders, hence decreasing the resources needed to evaluate irrelevant proposals.

Proceeding to the next stage, it is now necessary to evaluate the bids themselves using the award criteria. Historically, tenders were chosen solely based on the bidder with the lowest price. However, the implementation of the most economically advantageous tender (MEAT) through the European Directive of 2014 shifted the focus towards awarding tenders based on cost effectiveness, which takes into account additional factors such as quality, environmental impact, and safety (Sebastian et al., 2020). This allows clients to emphasise their prioritisation of safety and enables them to choose a contractor who has effectively addressed the safety requirements outlined in the bidding documents (WorkSafe Victoria, 2017). To do this, the client needs to build mechanisms through which the bidders can contribute their expertise. One approach to achieve this is by providing them with the chance to evaluate the safety hazards that were highlighted by designers in earlier stages (Musonda et al., 2013). An essential factor in attaining safety performance is the contractor's safety resources, with people playing a crucial role. The client can assure the appropriate selection of a contractor by assessing the resumes of key personnel given by the tenderers (Zuofa and Ocheing, 2017). Another crucial resource

is the amount of capital dedicated to safety measures. The client should only choose a contractor after ensuring that they possess the required competencies (Chunxiang, 2012). Finally, in order to gather project-specific information, the client might assess the bidders' dedication to safety by conducting interviews and visiting the project site (Ma, 2006).

After the client chooses the contractor, the next crucial step is to create a contract to carry out the project. This stage should not be underestimated, especially when it comes to safety, as it legally obligates both parties to comply with its terms. It is crucial for the customer to surpass the safety criteria stated in legislation and adopt additional safety measures through contractual provisions in order to accomplish their safety objectives (Zuofa and Ocheing, 2017). In addition, it is crucial for clients to go beyond the safety clauses included in standard contracts and instead focus on illustrating how these contractual elements should be implemented in the particular context of the project being carried out under the primary contract. One approach to achieve this is by aiding contractors in incorporating safety programme components, such as daily task safety analysis and subcontractor's safety inspection, within contracts (Chunxiang, 2012). Furthermore, an essential aspect of creating a contract for the project is to specifically discuss safety concerns during the negotiating process (Chunxiang, 2012). This is done to clearly define the safety obligations of all parties involved in the contract (Musonda et al., 2013). While this may be the last step in the pre-construction phase, it is crucial to acknowledge that the client's responsibilities do not cease here. The client must oversee the contract throughout the subsequent stages, as failure to do so would render all previous efforts futile. An overview all the client roles described in this section can be found in table 2.1:

Table 2.1: Best Practices for Construction Clients to enhance Safety Performance during Pre-construction phases by Raza et al. (2022)

Pre-construction Phase	**Client Roles as recognized by literature**	**Literature Source**
Planning, Inception, and Feasibility	To establish a "zero injury" objective at site	Lopes (2011)
	To include appropriate OHS risks into risk assessment process	Toole et al. (2017)
	To conduct an adequate risk assessment with appropriate stakeholders	Fleming et al. (2007)
	To identify general safety issues within the planning phase	WorkSafe Victoria (2017)
	To identify the specific safety issues from prior experience and similar projects while planning the project	WorkSafe Victoria (2017)
	To identify the risks by consulting with workers hired on ongoing similar projects	Ma (2006)
	To document all the identified risks for contractors and designers	WorkSafe Victoria (2017)
	To identify and design out safety issues and risks by redesigning corresponding part of the project	Votano and Sunindijo (2014)
	Clients should be involved in including OHS related specifications and standards in project objectives, project brief, and design requirements	Shafiei (2015)

Best Practices for Construction Clients to enhance Safety Performance during Pre-construction phases by Raza et al. (2022) (continued)

Pre-construction Phase	Client Roles as recognized by literature	Literature Source
	To hire competent designers for efficient risk assessment and consequent identification of and response measures against potential hazards	Toole et al. (2017)
	To appoint safety team throughout project phases	Ma (2006)
	To specify how safety is to be addressed in tenders	Toole et al. (2017)
Design	To give due consideration to safety issues identified from previous projects to avoid errors in present and future designs	WorkSafe Victoria (2017)
	To ensure that all OHS matters should be up to date in design	WorkSafe Victoria (2017)
	To keep check on design changes by reviewing design documents	Chunxiang (2012)
	To ensure that OHS clauses should be considered at the design stage without violating the related bylaws set by regulatory bodies for swift approval of design	Chunxiang (2012)
	To provide proper guidelines to design engineers for identifying and designing out the risks	WorkSafe Victoria (2017)
	To take every possible effort for identification of risks in design phase of project and categorize them on basis of their impact on stakeholders	WorkSafe Victoria (2017)
	To frequently interact with all stakeholders for effective collaboration and conduct meetings with agenda of safety for realization of safe design	Lingard et al. (2020)
	To share the knowledge related to risks and OHS to all stakeholders and review the design documents to ensure that risks are listed as identified	Abudayyeh et al. (2006)
	To establish with all stakeholders, the practices required for risk assessment and record risks associated with every construction activity	WorkSafe Victoria (2017)
	To set higher bars for OHS through implementation of PtD and DfCS	Gambatese et al. (2005)

Best Practices for Construction Clients to enhance Safety Performance during Pre-construction phases by Raza et al. (2022) (continued)

Pre-construction Phase	Client Roles as recognized by literature	Literature Source
	To ensure that design include OHS on the constructability, use and maintenance of the structures	WorkSafe Victoria (2017)
	To review with designers, all the proposed construction practices to avoid inheriting the risks	Votano and Sunindijo (2014)
	To make sure that designers must submit a hazard free design considering construction methods and site conditions	Toole et al. (2017)
	To ensure that the design team must consider OHS issues as required by the nature and type of project and project oriented specific OHS measures	Chunxiang (2012)
Tendering and Procurement	To involve OHS requirements in the tender documents to assess tenderer's knowledge about OHS matter	Toole et al. (2017)
	To involve a special clause about safety performance in the tender documents	Votano and Sunindijo (2014)
	To require from tenderer to produce OHS plan and the construction method details as a component of tender response file	Kikwasi (2008)
	To require an emergency plan to be included in the contractor's safety program	Ma (2006)
	To involve a clause in the tender documents explaining that non-compliance to OHS requirements as specified can lead to termination of the contracts	Chunxiang (2012)
	To involve an item of OHS in project cost estimate which is prepared by the consultants	Abudayyeh et al. (2006)
	To promote awareness of OHS by attaching the OHS related legislation documents within the tender documents and to ensure the application and enforcement of such OHS laws	Zuofa and Ocheing (2017)
	To detail the item covering OHS matters and given due consideration as other items	Huang & Hinze (2006)

Best Practices for Construction Clients to enhance Safety Performance during Pre-construction phases by Raza et al. (2022) (continued)

Pre-construction Phase	Client Roles as recognized by literature	Literature Source
	To select safe contractors by evaluating expertise of contractor's project management team and safety staff, contractor's total recordable injury rate (TRIR) on past projects, and quality of his safety program	Zuofa and Ocheing (2017)
	To ensure that the project execution method must make room for financially stable contracting firm suitable for project and aware of OHS measures for projects	Huang & Hinze (2006)
	To consider a tenderer who has responded well to the clause on OHS matters during awarding process	WorkSafe Victoria (2017)
	To bring in knowledge of tenderer, the OHS risks identified by design team	Musonda et al. (2013)
	To approve the resumes of key safety personnel submitted by the contractor	Zuofa and Ocheing (2017)
	To make sure that principal contractor bidding for contract have provided capital for OHS measures and appoint only after being satisfied regarding his necessary competencies and resources	Chunxiang (2012)
	To evaluate contractor by reviewing his commitment towards safety via site visits and interviews	Ma (2006)
	To establish minimum safety requirements in the contracts other than the legislation	Zuofa and Ocheing (2017)
	To make sure contractors include, in contract documents, safety program elements such as daily job safety analysis and subcontractor's safety inspection	Chunxiang (2012)
	To address OHS matters during contract negotiation	Chunxiang (2012)
	To clearly write in documents about OHS responsibilities of the parties to contract	Musonda et al. (2013)

2.3 Key Takeaways

What is the relationship between client involvement and safety performance on construction sites?

1. Clients as the as the instigators of projects, they possess the ability to establish stringent safety protocols for project execution, prioritising the well-being of their personnel from the outset, enhancing the likelihood of attaining elevated safety levels (Lingard et al., 2020).
2. Clients make many decisions can significantly impact safety performance during construction project execution(Gibb et al., 2014).
3. It has been noted that construction clients have the most significant influence in shaping the perception, motivation, and behaviour of other stakeholders when it comes to safety. This gives them the optimal ability to drive the necessary cultural shift for further enhancements in occupational health and safety (OHS) within the construction sector. ((Said et al., 2009, Lingard et al., 2009)
4. Vadsman (2006) determined that construction projects in which clients actively participated in safety-related activities experienced a notable reduction in occurrences and injuries.

What are recognized best practices for construction clients during pre-construction phases to improve safety performance?

A summary of the best practices for construction clients during pre-construction phases can be found in the table by Raza et al., 2022 as depicted in Table 2.1.

3

Research methodology

This section of the report will elaborate on how the third sub-research question will be answered. Given that this question aims at seeking a deeper understanding of human experience, semi-structured interviews have been recognized as the most common and effective method to achieve this purpose (Bearman, 2019). The semi-structured interviews will be conducted following a better understanding of the role client involvement plays on influencing safety performance and a theoretical understanding of the activities that clients should participate in during the pre-construction phases of a project, regarding safety. The objective at this stage is to understand how clients on different types of projects go about undergoing these activities, to understand if indeed the practices identified in literature are the best practices to influence safety performance, and if not to understand the activities that clients take part in to enhance safety performance. The idea here is to move away from a generalized understanding of the role of construction clients to a more specific evaluation of the role that infrastructure and oil & gas clients have on safety performance during the pre-construction phases of a construction project.

”Semi-structured interviews are flexible and versatile making them a popular choice for collecting qualitative data” (Magaldi and Berler, 2020). The flexibility and flow in the conversation with the participants comes from the open ended nature of the questions asked. This allows the ”participants to feel comfortable to reflect upon their own personal experiences, providing the researcher an in-depth understanding of a particular area of interest”(Magaldi and Berler, 2020). This could be of benefit in the case of this research as it can provide the opportunity of obtaining insights from participants regarding their experiences, perceptions, and attitudes towards safety practices and policies. The ability to obtain in-depth understanding of the research topic presents the chance to understand the complex interactions between various factors such as policies, procedures, human behavior, and environmental conditions which are all involved with safety at the workplace. Moreover, the utilization of semi-structured interviews allows for clients to reflect on the pre-construction safety roles identified in literature in a more nuanced perspective, which might not be achievable through quantitative data collection methods. Given that the topic of this research is related to safety there are a number of things that are embedded in the organizational culture and context of companies and through semi-structured interviews it is more likely to obtain information like this when compared to more structured research methods. ”One of the main advantages the semi-structured interviews is that it allows the subjects’ open responses, instead of affirmative or negative brief answers”(Harvey-Jordan). This benefit of semi-structured interviews is beneficial for this research because it provides the opportunity for more genuine and insightful responses, especially when discussing sensitive topics like safety. Keeping these benefits in mind and its contextual suitability to the research in hand the semi-structured interview methodology was chosen for this stage.

3.1 Interview Guide

The first step in this process is developing an interview guide that will help the researcher conduct the actual interviews. As previously discussed a key element of the interview guide is that the questions must be open-ended but directed towards a central research topic and must be flexible enough to allow for dialogue to emerge between the interviewer and the interviewee (Magaldi and Berler, 2020). This step must be performed with utmost caution as it informs the implementation and analysis of the interviews (Magaldi and Berler, 2020). The basis of the formation of the interview guide for the semi-structured interviews is literature study that was conducted prior to this stage of the research. The key findings from literature represent that client involvement in safety matters during the pre-construction

phase can indeed help improve safety performance on construction projects. Literature also showcases the roles that a construction client should play in the different pre-construction phases: Planning, Inception, and Feasibility; Design; and Tendering and Procurement. However, up to this stage in the research there was no focus on different types of construction projects which this phase aims to introduce. The questions in the interview guide will be derived from the roles identified from section 2.2.

The questions will be formulated into sections based on the different pre-construction phases in order to dictate the flow of the interview. The complete interview guide can be found in Appendix A.1. However, the general flow of the interview questions was as follows:

1. The participant was asked about the importance that clients (depending on the participant it would be about oil & gas clients or infrastructure clients) give to safety performance.
2. The participant was asked about the risk identification process of the client during the planning, inception, and feasibility phase.
3. The participant was asked about how clients selected their designers.
4. The participant was asked about the role clients play in accepting safe designs.
5. The participant was asked about the risk identification process in the design phase and about the stakeholders involved in this step.
6. The participant was asked about the role of the client in the consideration of safety of the future stages of construction in the design phase itself.
7. The participant was asked about how the client considers safety during the development of tender documents.
8. The participant was asked about how the client selects a safe contractor to carry out his work.
9. The participant was asked about the role that safety plays during the contract negotiation process.

3.2 Practitioner selection

Once the questions are prepared the next stage involves the selection of participants for the interviews who should be knowledgeable and can provide valuable insights related to the research topic in hand. The semi-structured interviews will be conducted through two domains, participants involved in oil & gas projects and those involved in infrastructure projects. With the objective of obtaining multiple perspectives both contractors and clients were involved in the interview process. For the purposes of this research a total of nine interviews were conducted, of which three participants were clients working on oil & gas projects, two were contractors working on oil '& gas clients, two were clients working on infrastructure projects, and two were contractors working on infrastructure projects. A brief description of their roles and their experience is provided in Table 3.1:

Table 3.1: Participants of Semi-structured Interviews

Participant	Designation	Experience (years)
Client 1 (O&G)	HSSE Project Consultant	20
Client 2 (0&G)	Manager: Technical Integrity & Process Safety	15
Client 3 (0&G)	Safety Officer	5+
Contractor 1 (0&G)	HSE Director	10
Contractor 2(O&G)	HSE Manager	21
Client 1 (INF)	Senior HSE Manager/Coach	16
Client 2 (INF)	Safety Expert	25+
Contractor 1 (INF)	SHEQ Specialist	16
Contractor 2 (INF)	HSE Specialtist	11

The advantage of taking this approach is that it allows for the demonstration of how these various perspectives differ, giving both clients and contractors the opportunity to reconcile these differences and develop roles and responsibilities for both parties that can be agreed upon, allowing for higher levels of safety performance. A combination of purposive and snowball sampling were utilized for the selection of the interview participants. The initial approach was to obtain recommendations of potential participants from various professors at the TU Delft based on the inclusion and exclusion criteria (mentioned later in the paragraph) that was shared with these lecturers. The next step was to approach potential participants by messaging them via LinkedIn. By approaching professors and reaching out through LinkedIn I was able to schedule 5 of the 9 interviews and the others were scheduled via snowball sampling. In both cases (reaching out to potential participants through professors and through LinkedIn) an invite letter, attached as Appendix A.2, was shared to the participant which articulated that the results will be reported anonymously and that the interviews being conducted will be recorded for the purpose of transcription.

The inclusion criteria for the participants in this interview process was as follows:

1. The participant must hold a role in any safety position (safety manager, officer, executive).
2. The organization that the participant works for must work on infrastructure or oil&gas projects.
3. The participant must be working in a safety related role for more than 5 years.
4. The participant must be working in the Netherlands region.
5. Lastly, the participant must be willing and able to accommodate time for the interview.

The exclusion criteria for the participants in this interview process was as follows:

1. The participant must be able to converse, at least to a decent level, in English. With this criteria it is important to note that perfect English is not expected but enough to get the point across.
2. The researcher aimed at not including participants that work on both oil & gas projects and infrastructure projects as it may lead to certain biases that were trying to be avoided.

3.3 Conducting the Interview

The next stage in this process is conducting the interview, which can be deemed as the most important step in this stage of the research as it is where the actual data for the research is being collected. The first phase in the interview process is a period during the interview where the researcher will introduce the research topic, build a rapport with the participants, and the participants can ask questions about the research (Whiting, 2008). Following this introduction phase the interview will progress to more

challenging questions as the rapport between the participant and the interview develops, finally ending in a free-flowing conversation with the ability to pick up many insights (Whiting, 2008).

The interview process was conducted between February 2024 and May 2024, all interviews apart from one were conducted online. The online tool Microsoft Teams was used to conduct the interview and due to its inbuilt recording a transcription that provides a raw transcript the final manual transcription was made easier. A test interview was conducted from which the feedback of reducing the number of questions by formulating them as sub-questions improved the flow of the interview, so that update was made for further interviews. The duration of the interviews ranged from 45 minutes to 120 minutes. It was agreed at the end of the interviews that the results and recommendations that come out of the research will be shared with all participants for expert validation. Meaning that the participants have the opportunity to comment on the recommendations that the researcher comes up with so they can be updated to incorporate feedback from practitioners in the construction industry.

3.4 Data Analysis

Once the interviews are conducted the next stage is the analysis of the data collected in the interviews such that it can be presented in a manner that addresses the research question in hand. The first step in the analysis of raw interview data is data preparation, this a procedure where the researcher ”is required to clean the raw data and put them into a form that is easy to work with”(Ruslin et al., 2022). For the purposes of this research the method used for data preparation was the manual transcription of the interviews conducted. ”The second step is analysis in which the interviewer is required to try various ways of categorising and reorganising the prepared data and seeking patterns related to the research questions” (Ruslin et al., 2022). To do this the tool atlas.ti was used, a tool that has been recognized to facilitate coding, to organize, and to identify emerging patterns in the interviews (Ñañez Silva et al., 2024). Moreover, the atlas.ti has been accepted as a highly beneficial tool in qualitative data analysis through improved data management and through its ability to display the interviewees perspectives(Ñañez Silva et al., 2024).

The first step in the data analysis is adding all the transcripts to one ”project” on the software, then the initial coding process can begin. ”The aim of the initial coding process is to label the topics mentioned by the respondants to describe what is in the data” (Friese et al., 2018). For the purposes of this research the initial codes that were generated were based off the roles identified in literature and depicted in Table 2.1. Table 3.2 below depicts the initial codes that were generated in this step of the data analysis.

Table 3.2: Initial coding as generated on atlas.ti

S/No.	Initial Codes generated on atlas.ti
1	Consideration of safety in the preparation of project brief
2	Considerations taken while hiring human resources
3	Consultation with workers for identification of risks
4	Documentation and Transfer of Risks to further teams
5	Hiring design team that have the ability for risk assessment
6	Identifying general safety issues within the the planning phase
7	Identifying safety specific issues from prior experience and similar projects
8	Measuring safety performance
9	Pre-construction phases on a typical project
10	Risk Identification and its affect on scope

S/No.	Initial Codes generated on atlas.ti
11	risk identification process in the planning phase
12	Safety as a performance indicator
13	Safety objectives
14	when is safety introduced
15	Considering the safety of future construction phases during designs
16	Ensuring designs don't violate related bylaws
17	Ensuring design team considers safety issues as required by the nature and type of project
18	Ensuring safety matters are up to date in designs
19	Establishing practices for risk assessment and recording
20	Interaction with Stakeholders during Design Phase
21	Involving and allocating risks to stakeholders in the design phase
22	Provision of guidelines for identifying and designing out risks
23	Assessing tenderer's knowledge on safety
24	Assessment of who responded well to clauses on safety matters
25	Bringing the Knowledge of Tenderer on board
26	Contractor Documentation other than HSE Plan
27	Costing of safety
28	Non-compliance to safety in tender documents
29	Safety during contract negotiation
30	Safety matters compared to others in tender documents
31	Safety performance in the tender documents
32	Selecting a financially stable contractor and its affect on safety outcomes
33	Sharing knowledge related to safety risks to stakeholders
34	stakeholders in planning phase
35	Tenderer's commitment to safety
36	TRIR and past experience and its role in selecting a safe contractor
37	Regulation in the netherlands
38	Infrastructure clients moving towards 2-phase contracting
39	Client responsibility as affected by new law
40	Additional roles

The next step in this stage is code all the transcripts according to the above established initial coding system. Once all transcripts have been coded, the codes were grouped into themes. For the purpose of this research, since it aims to determine what roles clients should play in the pre-construction phase to improve safety performance the themes selected were the pre-construction phases itself: Planning,

Inception, and Feasibility; Design; Tendering & Procurement. Along with this one other theme that was introduced was Legislation and Two-phase contracts as it seemed to represent particular sections of the data, especially from the safety professionals working on infrastructure projects. The affects of this and the details regarding the information shared pertaining to these codes will be elaborated in the following chapters. The Tables 3.3, 3.4, 3.5, 3.6 represents the final coding system that depicts the themes that were identified and the codes that fit into said themes.

Table 3.3: Theme 1: Planning, Inception and Feasibility and its related quotes

S/No.	Codes corresponding to Theme 1 (PIF)
1	Consideration of safety in the preparation of project brief
2	Considerations taken while hiring human resources
3	Consultation with workers for identification of risks
4	Documentation and Transfer of Risks to further teams
5	Hiring design team that have the ability for risk assessment
6	Identifying general safety issues within the the planning phase
7	Identifying safety specific issues from prior experience and similar projects
8	Measuring safety performance
9	Pre-construction phases on a typical project
10	Risk Identification and its affect on scope
11	risk identification process in the planning phase
12	Safety as a performance indicator
13	Safety objectives
14	when is safety introduced
15	Stakeholders in the planning phase

Table 3.4: Theme 2: Design and its related codes

S/No.	Codes corresponding to Theme 2 (Design)
1	Considering the safety of future construction phases during designs
2	Ensuring designs don’t violate related bylaws
3	Ensuring design team considers safety issues as required by the nature and type of project
4	Ensuring safety matters are up to date in designs
5	Establishing practices for risk assessment and recording
6	Interaction with Stakeholders during Design Phase
7	Involving and allocating risks to stakeholders in the design phase
8	Provision of guidelines for identifying and designing out risks

Table 3.5: Theme 3: Procurement and Tendering and its related codes

S/No.	Codes corresponding to Theme 2 (P&T)
1	Assessing tenderer's knowledge on safety
2	Assessment of who responded well to clauses on safety matters
3	Bringing the Knowledge of Tenderer on board
4	Contractor Documentation other than HSE Plan
5	Costing of safety
6	Non-compliance to safety in tender documents
7	Safety during contract negotiation
8	Safety matters compared to others in tender documents
9	Safety performance in the tender documents
10	Selecting a financially stable contractor and its affect on safety outcomes
11	Sharing knowledge related to safety risks to stakeholders
12	stakeholders in planning phase
13	Tenderer's commitment to safety
14	TRIR and past experience and its role in selecting a safe contractor

Table 3.6: Theme 4: Legislation and two-phase contracts and its related codes

S/No.	Codes corresponding to Theme 4 (Legislation and two-phase contracts
1	Regulation in the netherlands
2	Infrastructure clients moving towards 2-phase contracting
3	Client responsibility as affected by new law
4	Additional roles

As mentioned earlier an advantage with atlas.ti is that it also allows for understanding the perspectives of the different participants of the interviews. This research included safety professionals of both clients and contractors participating in oil & gas and infrastructure projects. Therefore it is important to understand how and where opinions vary and match between the different groups of participants. Table 3.7 below represents how the different groups of participants responded to the categorized themes reffered to in Tables 3.3,3.4, 3.5, & 3.6. The table will showcase the different themes against the different groups of participants and the number of quotes that correspond to each element. By doing so a clearer understanding of the perspectives in relation to client safety specific pre-construction roles. The importance of these perspectives and more specific thematic analysis based on quotes from interviews is elaborated in the following chapter.

	Clients Infrastructure	Client Oil & Gas	Contractors Infrastructure	Contractors Oil & Gas
Planning, Inception, Feasibility	48	135	45	28
Design	32	72	24	13
Tendering and Procurement	51	108	32	15

Table 3.7: Themes as distributed by perspectives of participants

The final step is to present the results by developing patterns from the responses to develop conclusions, which will allow this research to progress into developing recommendations for both infrastructure and oil & gas clients regarding pre-construction safety roles.

3.5 Expert Validation-Methodology

The final stage of this research is conducting a round of expert validation with safety professionals in the construction industry, which will finish answering the third sub-research question: “What role do infrastructure and oil & gas clients play during pre-construction phases to improve safety performance, from the perspective of clients and contractors?” The idea with this stage of the research is to showcase the results, discussions, and recommendations developed from the previous phase of the research to a couple of experts on safety in the construction industry to validate the and brainstorm whether the recommendations can be practically implemented. For this stage, once the recommendations are drawn out based on the semi-structured interviews they will be shared with all interview participants to obtain their expert opinion, which will help to validate whether the recommendations can truly improve safety performance.

Following the stages that are detailed in this section will allow to answer the main question: “How can construction clients optimize their roles during pre-construction phases of infrastructure and oil & gas projects to enhance safety performance?”

4

Results

In this section of the report the results from the interviews will be reported as per themes presented in section 3.4. This will be done by identifying quotes from the interview transcripts that correspond to the themes identified. In other words the quotes that represent specific pre-construction client safety roles will be presented against the different pre-construction phases.

4.1 Planning, Inception, and Feasibility

It is important to start the project with safety in mind and requires the client to establish a zero-injury objective. Infrastructure clients and contractors agree that “they (clients) don’t set objectives for safety” (Contractor 1 (INF)) because infrastructure clients are “a governmental organization so they must follow tender legislation to bid making it difficult to focus on safety performance”(Client 1 (INF)). Moreover, it was reflected by Contractor 2 (INF) that in the cases where safety objectives are set “they are mostly lagging indicators”. In the case of oil and gas projects, both clients and contractors mentioned that they (O&G clients) look at safety as an “iceberg and consider the near-misses and not just pay attention to the accidents”(Client 1 (O&G)). In dispute to this Contractor 1 (O&G) mentioned that their clients “establish safety objectives but I believe it is only a facade, I don’t think safety is a priority”.

The next task that clients need to perform is the initial risk identification process, of the wide variety of risks that persist on construction projects one type of risk is the safety risks. It is crucial that the client considers safety risks in the initial risk identification process. All contractors, both O&G and Infrastructure, mentioned in some way or the other that “we as contractors are not involved early enough unfortunately” (Contractor 2 INF). Clients on both types of projects reflected that they will include safety risks in their risk assessment process albeit in different ways: “safety officer is involved and he will assess the alternatives” (Client 2 (INF)); “before we go to the market my job is to make a risk visual” (Client 1 (O&G)). During risk identification it is important for the client to include all relevant stakeholders in the process but through the interviews it was mentioned that clients on both type of projects only include internal stakeholders at this stage: “we would have a project management team involved in the risk assessment process” (Client 1 (INF)); “all stakeholders will be within my company itself at this stage” (Client 1 (O&G)). The identification of general safety issues needs to include the client in the process because it is important to have “knowledgeable people around” (Contractor 1(O&G)). Looking into the portrayal of this role, infrastructure contractors expressed that they “would like them (infrastructure clients) to perform this role so they can take the risk assessment from there” (Contractor 1 (INF)). However, it was seen that the portrayal of this role really “depends on the kind of project that it is, if the client is responsible for the design we see that he does some risk assessment but if we are doing the designs they are hardly involved” (Contractor 2 (INF)). When infrastructure clients do portray this role they do it by “having a standard risk database” (Client 2 (INF)). On the contrary in oil & gas projects the general safety issues are identified as the “first step of the HAZID” (Client 1 (O&G)), although the client “expects us (O&G contractors) to take a leading role in identifying safety related risks” (Contractor 2 (O&G)).

Sharing information about safety issues from prior experience and similar projects to assist the identification of risks is a role that the client can portray to increase safety performance. Infrastructure contractors mention that “it depends on the client, some are more advanced in sharing lessons learnt and others don’t bother” (Contractor 1 (INF)) and in the cases that information is shared, “it is not sufficient” (Contractor 2 (INF)). Clients of Infrastructure projects agreed to this mentioning that “in infrastructure that is something underdevelopment right now” (Client 1 (INF)). Looking into how this role

is portrayed on oil & gas projects it can be seen that “it (sharing lessons) doesn’t happen enough because of the need of vast amount of data” (Contractor 1 (O&G). Contractor 2 (O&G) reflects that “clients are reluctant to share safety challenges” despite this sharing of information and knowledge being the “missing piece” (Contractor 1 (O&G)). However, when clients in O&G projects reflect on this role, they all mention in some fashion or the other that “they have access to a database that informs them about every incident occurred on company projects” (Client 1 (O&G)). Similar to the role of sharing information about safety issues from prior experience and similar projects another role that can help in the risk identification process is consultation with workers hired on similar on-going projects. A clear distinction can be observed between O&G clients and infrastructure clients when it comes to the portrayal of this role. Infrastructure clients recognize that “it is important to consult ground staff” (Client 1 (INF)) yet “don’t consult with workers on similar projects” (Client 2 (INF)). When we look at this role from the perspective of O&G clients, it is seen that they “definitely consult workers hired on similar projects” (Client 2 (O&G)). The last step in the risk identification process is to document all identified risks for contractors and designers. This role is executed by different clients differently, they could document their risks using a “risk management program” (Client 1 (INF)), “safety risk database” (Client 2 (INF)), “SharePoint document management system” (Client 1 (O&G)). Clients are responsible for developing the scope of the project, when doing so it is important to design out safety issues by reconsidering the scope of the project. When asked to reflect on this Contractor 2 (INF) mentions that “as a contractor I am not involved early enough to be able to redesign aspects of the project”, whereas infrastructure clients see the importance of this role and do indeed “design the scope based on whether it is possible to safely execute the work” (Client 2 (INF)). Oil and Gas similarly recognize the importance of executing this role and “conduct the work only if the work can safely continue or else the scope must change” (Client 1 (O&G)). However, “the client is not too familiar with the process of re-assessing the scope of the project so they often hire external consultants” (Contractor 1 (O&G)).

Once the risk identification process of this phase is completed the client needs to prepare the project objectives, project brief, and design requirements, in which he should include safety related specifications and standards. Reflecting on this role Client 1(INF) mentions that “a file will be prepared that addresses construction, technical and organizational decisions based on the choices we made”. Oil and Gas clients mention that “safety details are included in the first paragraph of any project brief”. The next crucial role that the client needs to portray is hiring a competent design team that can conduct an efficient risk assessment. Infrastructure clients mention that they take into consideration “past experience, safety stats, on top of which we will ”share with the design team the risks that we are having a hard time assessing we would put our problem as a challenge to the market and make a decision on the best solutions that come up” (Client 2 (INF)). However client 1 (INF) disagrees and mentions that “I think this is something we still need to develop, so we have our project teams but in the planning phase we don’t have specific requirements for that other than the internal company requirements”. When it comes to O&G clients they “ask for a presentation in order to understand if we will be working with a mature team or not, we try to understand if safety is lacking behind” (Client 1 (O&G)) and will ask “for previous experience, and tend to work with EPC contractors that we have worked with before” (Client 2 (O&G)). Lastly in the design stage, the client has to appoint his safety team for all stages of the project. Taking a look into what considerations are taken when the clients are hiring their own safety staff that infrastructure clients require “a safety specialist with high or medium amount of education on health and safety legislation” (Client 1 (INF)) and an “industrial safety background or structural safety background” (Client 2 (INF)). Similarly oil and gas clients also hire their safety staff based on “qualifications, experience, and competency” (Client 2 (O&G)). However, Contractor 1 (O&G) mentions that “the client has a very strong team and sometimes it gets annoying”.

4.2 Design

Moving into the design phase the client should ensure that safety matters are up to date in the different versions of the design. Speaking to this role, both type of contractors mention the use of various reviewing mechanisms including “version review” (Contractor 1 (INF)), “management of change procedures” (Contractor 2 (INF)), “stage gate reviews” (Contractor 2 (O&G)). Infrastructure clients further elaborate that keeping safety matters up to date through the design process is done by having “a design coordinator on board, which is also mandated by legislation, who will be in constant touch with

the design team" (Client 1 (INF)). In addition to the review process and communication with the design team Client 2 (O&G) mentions that "standards are established for designs and all designs needs to be signed off by our company engineers". The designs of a project go through various approval processes, one is the approval by regulatory bodies. The client should make sure that the design team finalizes the designs without violating the related bylaws to permit a swift approval process. To conduct this role infrastructure clients reflected that either the role is "managed by the design team" (Client 1 (INF)) or by "safety officers who are more aware of legislation and will ensure we comply" (Client 2 (INF)). Similarly O&G clients mention that "it is the responsibility of the Owner's Engineer" (Client 1 (O&G)) or "project risk manager who is responsible for going through all local legislation" (Client 2 (O&G)). The client needs to take the responsibility of providing proper guidelines for identifying and designing out risks. Both types of contractors stress that "it is written in the local and EU regulations" (Client 1 (O&G)); "we have to work according to Arbo Law". Reflecting on this role Client 1 (INF) mentions that they "have complete guidelines, we provide clear instructions on how to develop the designs". Oil and Gas clients similarly provide guidelines to the design team to design out risks, using their "overarching HSE cultural framework that needs to be made into a HSE management system based on local conditions" (Client 1 (O&G)).

In the design phase it is crucial to involve a wide range of appropriate stakeholders to enable an efficient risk assessment process. An important role, with the involvement of such stakeholders, is to identify and categorize safety risks on the basis of impact on stakeholder. Client 3 (O&G) recognizes the importance of this role and mentions that "by involving all relevant parties, we can proactively address hazards and create designs that prioritize safety from the outset". Going into more detail about this role it is seen that "the HAZID has a column that addresses who is the stakeholder that is most impacted and who is responsible for addressing that risk" (Client 1 (O&G)). Although this role is seen to be executed on oil and gas projects, it was seen that "in terms of identifying and distributing safety risks to different stakeholders the client expects us (oil and gas contractors) to take the lead role" (Contractor 2(O&G)). On infrastructure projects clients "allocate 11 or 12 safety areas to different stakeholders" (Client 1(INF)). When involving stakeholders in the risk assessment process it is important for the client to conduct frequent interactions with them with the agenda of realizing safe designs. Reflecting on this role infrastructure clients mention that "this really depends on the type of project but generally we have weekly and bi-weekly meetings with the design team" (Client 1(INF)). In disagreement Contractor 1 (INF) mentions that "when we make the design we are in charge and we involve them (infrastructure clients) at various times with updates, but when they are in-charge we are not involved at all". Similarly on oil and gas projects clients reflect that they interact with relevant stakeholders "weekly, bi-weekly, monthly depending on the stakeholder" (Client 1 (O&G)) but contractors mention that they "involve the client and other stakeholders through HSE meetings" (Contractor 2 (O&G)). It is not enough to involve stakeholders in the risk assessment process it is also important for the client to share his knowledge about safety risks to all stakeholders. Oil and gas clients mention that this is done through "an interactive workshop regarding various safety topics" (Client 1 (O&G)), "by developing a basis to design document, which will provide the foundation for the designs" (Client 2 (INF)). Similarly on infrastructure projects all knowledge that clients have about risks will be shared through the "health and safety plan" (Client 1 (INF)) and "by conducting workshops and informal discussions" (Client 2 (INF)).

Another important aspect to take into consideration in the design phase is the safety challenges that might arise in the future stages of a construction project. In doing so the client can implement of the concepts of Prevention through Design (PtD) and Design for Construction Safety (DfCS) as "it can contribute to safer designs and better outcomes for workers, users and the environment" (Client 3 (O&G)). Reflecting on this infrastructure clients mention that they "expect this (implementation of Ptd and DfCS) to be standard practice but they still need to keep reminding the design team to take into account future construction stages" (Client 1 (O&G)). Infrastructure contractors agree and mention that "more and more clients are taking these concepts into account due to the obligation to verify" (Contractor 1 (INF)). Oil and gas clients mention that "the complete construction life-cycle is considered during the design from inception to demolition" (Client 1 (O&G)). However, Contractor 1 (O&G) mentions that "the client needs to play a bigger role in transferring this knowledge to the teams that will be executing the future stages of the project". In further detail of the future stages it is important for the client to ensure that designs include safety on constructability, use and maintenance of assets. Client 1 (INF) mentions

that “more attention needs to be paid on the maintenance phase and to do this we need more safety specialists on board”. In contrast on oil and gas projects “a suit of engineers from various disciplines will be on board to assist in the consideration of maintenance and operation phases” (Client (O&G)). Lastly in the design phase it is important that the client ensures that the design team takes into consideration nature, type and site conditions of project. Reflecting on this Contractor 2 (INF) mentions that this is “not done sufficiently enough”, however, clients on infrastructure projects are “working on having safety specialists on each project management team, which will assist with this role” (Client 1 (INF)). In the case of oil and gas projects, clients mention that these considerations are taken through the “HAZID process” (Client 1 (O&G)) and by being “transparent with information” (Client 2 (O&G)) and Contractor 2 (O&G) mentions that “if this information is shared the client can ensure site conditions are taken into account in the designs”.

4.3 Tendering and Procurement

The final pre-construction phase tendering and procurement includes the selection of the contractor who will execute the clients work for him, considering safety here is important. The first role that clients need to portray is to involve safety requirements in the tender documents to assess the tenderer’s knowledge about safety matters. Infrastructure clients mention that they portray this role by “reviewing the HSE plan, as it is the contract for all things safety” (Client 1 (INF)) and by “challenging the tenderers to come up with solutions to specific risks we found challenging”. Infrastructure contractors add to this by mentioning their clients consider “the previous projects that we have executed” (Contractor 1 (INF)). In the case of oil and gas projects clients assess the tenderers knowledge through “an IOGP questionnaire” (Client 1 (O&G)), “by looking at safety record, the competence, asking them to demonstrate their safety management system” (Client 2 (O&G)) and by “conducting an office audit” (Contractor 1 (INF)). It is important that the client involve special clauses about safety performance in the tender documents such that contractors are aware of what they are being assessed against. Upon contemplation on this role infrastructure clients mention that they will “have a checklist detailing how we (infrastructure clients) will evaluate the contractor in regards to safety” (Client 1 (INF)). Similarly on oil and gas projects “safety performance is addressed in tender documents in quite some detail, including kpi’s” (Client 2 (O&G)) and “by having personal conversations with the contractor’s tender team to ensure they understand the requirements fully” (Client 1 (O&G)). In addition to including how safety performance will be addressed in the tender, it is important to involve a clause in the tender documents explaining that non-compliance to safety requirements as specified can lead to termination of the contract. Both types of clients specified that they “can be more strict on this aspect” (Client 1 (INF)) and that they “mention how non-compliance is to be addressed but have mild terms unless the contractor really messes things up” (Client 1 (O&G)). Moreover, clients further state that this is because “we (O&G clients) recognize that there is a huge HSE competency gap between the contractor and the client” (Client 1 (O&G)) or because it is “not in the nature of the contractor to think about safety clauses of the contract” (Client 2 (INF)).

Next the client needs to prepare to approach the market to find contractors, in this process the client needs to develop a structure for the cost estimate for the tenderers to fill in. It is important that the client involves detailed divisions into the safety related costs. Infrastructure clients mention that “when it comes to the detail in the BOQ, safety is not covered in detail” (Client 2 (INF)) but mentions that “costing of safety is better on two-phase contracts” (Client 1 (INF)). In contrast on oil and gas projects, costing for safety is “a separate item and is detailed much further into subdivisions” (Client 1 (O&G)) with a “minimum detail including costs for PPE, safety equipment, first aid kits, safety training and education, safety personnel and management” (Client 2 (O&G)). It is important to include safety, not only through costing, but through tender documents in an equivalent detail to other matters. Upon consideration of this role infrastructure clients and contractors agree that “safety is not considered to an equivalent to other matters” (Client 1 (INF)). In contrast on oil and gas projects “safety is addressed in extreme detail” (Client 1(O&G)) and “forms a core part of the contract” (Client 2 (O&G)).

The last stage of this phase is the selection of a safety conscious contractor, in this stage the contractor should be selected by evaluating the contractor’s total recordable injury rate on past projects. Infrastructure clients mention that it is “difficult for them to consider TRIR due to procurement rules”

(Client 1 (INF)). Similarly on oil and gas projects contractors are selected based on “visiting the clients counterpart in the contractors organization and having a discussion” (Client 1 (O&G)) and not really by looking at TRIR on past projects. In the selection of contractor the client should make room for a financially stable contractor aware of safety measures for projects. Client 2 (INF) mentions that “it is about the safety standards of the company and not the financial stability”. Taking the perspective of safety professionals working on oil and gas projects, clients had a varying opinion on this role where Client 1 (O&G) mentions they “only work with middle-high range contractors” and Client 2 (O&G) mentions that “they have a very strong policy for going for the cheapest contractor”. Whereas, Contractor 1 (O&G) stated that ”this depends on the type of contract, when it is a lump sum contract you need a financially stable contractor”. The client needs to select the tenderer who has responded well to the clauses on safety matters during the award process. Infrastructure clients reflect that “there is a whole team working on it” (Client 1 (INF)) and will select the tenderer “based on the questions we ask the tenderers and the answers they give” (Client 2 (INF)). Client 2 (O&G) add on to mention that they look at “the ease of negotiation with the contractor”, however, Contractor 1(O&G) mentions that they “have no clue how clients evaluate which tenderer responded well with the safety clauses, it is a secret”. In the tendering process it is vital for the client to bring the knowledge of the tenderer into the previously identified risks. Infrastructure clients specified that they do this “through a dialogue session” (Client 1 (INF)) and by “throwing a challenge and asking tenderers to come up with solutions” (Client 2 (INF)). Infrastructure contracts agree to this and remarked that “the client does indeed ask our (infrastructure contractor’s) opinion on some of the challenges they identified in previous stages” (Contractor 2 (INF)). In contrast on oil and gas projects “the contractor’s knowledge is not really involved in the tender phase” (Client 2 (O&G)) but at times they do “challenge the tenderer to find issues in our HAZID” (Client 1 (O&G)).

An influential aspect in regards to safety on construction projects is the staff of the contractor, making the approval of key safety personnel a pivotal role that the client should execute. In contemplation of this role Client 1 (INF) mentions that they “approve safety staff based on review of their CVs”, whereas, infrastructure contractors articulate that “this depends on the client some require certain qualifications, others require CVs, some go as far as conducting interviews” (Contractor 2 (INF)). Similarly on oil and gas projects clients would “require CVs of key safety personnel” (Contractor 1 (O&G)) and “would expect no less than 10years of experience for safety managers and 5 years for safety supervisors” (Contractor 2 (O&G)). The final consideration in the selection of a safe contractor is for the client to evaluate the contractor by reviewing his commitment towards safety. Infrastructure clients alluded to the fact that they conduct this role by “visiting the site and by checking if the contractor is working according to the HSE plan” (Client 1 (INF)) and by evaluating “if they come up with smart solutions to the problems that we throw at them” (Client 2 (INF)). In the case of oil and gas projects, clients ensure that they select a contract based on their commitment to safety through “a go/no-go criteria based off which an audit will be conducted” (Client 1 (O&G)); by “looking at the contractors safety trends” (Client 2 (O&G)); and by looking at “their SMS, Risk assessment participation, documentation and communication, contractor compliance and safety policies, safety record, training and competence, and monitoring and adjustment” (Client 3 (O&G)). Lastly, the client should make certain that safety is considered during the contract negotiation process. Both clients and contractors from both types of projects express to some extent that “the team in the bidding process is not the same as the execution team, who may not execute the plan that was prepared taking a lot of time” (Client 1 (INF)).

4.4 Legislation and Two-phase contracts

This theme address what certain participants said about the effects of the new safety legislation in the Netherlands on the role of clients and what was mentioned about the effects of utilizing two-phase contracts on safety performance. This is what the researcher would like to call a mini-theme as it doesn’t directly relate to the research objective but is included in the results as it presents opportunities to discover how the new safety legislation and two-phase contracting can help in improving safety performance through the optimization of the pre-construction safety specific roles of the clients. This theme was dominated by inputs from Infrastructure clients and contractors and didn’t include any statements from oil and gas clients and contractors. First, looking into the affects of the new legislation on the role of the client, contractors share their opinion of the new legislation and mention that it has led to their clients ”hiring a lot of new safety consultants, making sure that they also have the knowledge about

working safe and they're not just leaning on the contractor" (Contractor 1 (INF)). Moreover, Contractor 2 (INF) mentions that the new legislation has assisted in "clients insisting to implement PtD and DCfS due to the obligation to verify in the new legislation". Clients agree and add that considering the safety in maintenance and operation has improved with the new legislation because it "states that every new building you make you have to provide a list with information about how you will maintain the asset" (Client 1 (INF)). Moreover, through the new legislation "the government wants the client to take more responsibility in the design phase and have to make more explicit the kind of choices we make and how" (Client 2 (INF)).

The next aspect of this mini-theme is addressing the shift to two-phase contracting and understanding the benefits in relation to safety. Reflecting on this role contractors articulate that they "see that the future is two-phase contracts because you develop the designs together with the client yet you still have the option of stepping out" (Contractor 1 (INF)). Moreover, it (two-phase contracting) provides the opportunity for contractors to "advise the client early on in a project when the design is not set in stone" (Contractor 1 (INF)). Two-phase contracts also are beneficial in risk assessment and mitigation because "the eventual risk that will show up in the execution can be tackled better as both parties are in a team together, so you are dealing with shared challenges" (Contractor 1 (INF)). Similar to infrastructure contractors, infrastructure clients also highlight the benefits of two-phase contracting in relation to safety. Client 2 (INF) mentions that "safety is better on two-phase contracts because everything you do in the tender you can talk about together in the bouwteam (first phase of two-phase contracting) and you make the choices together and financially you are in it together and you can allocate risks better". Moreover, two-phase contract allows clients "to create extra demands on health and safety so it is much easier in the design phase" (Client 1 (INF)).

5

Discussions

This section of the report will discuss the results formulated in the previous section, and will be divided by the three pre-construction phases: Planning, Inception, and Feasibility; Design; and Procurement and Tendering. This section of the report will highlight specific roles based on the differences observed between how these roles are portrayed in practice compared to literature, as well as the variations in how different clients portray these roles.

5.1 Planning, Inception, and Feasibility

It has clearly been indicated in literature that one of the first roles that client should portray is to establish their safety objectives and performance indicators for safety. More specifically, Lopes (2011), mentions that clients should establish a ”zero-injury” objective. From the results it can be seen that this is not enough and can be stricter like in the case of Oil & Gas projects. Despite this, contractors reflect that these objectives seem to be strict on paper but is not reflected in practice. Infrastructure clients, on the other hand, seem to not be able to establish strict enough safety objectives and had blamed this on the tender legislation. By strict objectives the researcher is trying to articulate that it is important to set safety objectives that address safety pro-actively by looking into the near-misses and incidents rather than considering safety once injury has occurred. The next big role that the client must execute within this phase is the risk identification process (Fleming et al., 2007). The results show here that, although both types of clients conduct a risk assessment process they do not involve their contractors early enough, restricting their ability to assist the client. The lack of involvement of the contractors effects the proper execution of other roles as well, like, developing the scope of the project based on the risk identification process. The identification of risks in this phase can be greatly benefited by looking into similar safety issues from prior experience and similar projects (Ma, 2006). This type of knowledge sharing does not happen on infrastructure projects, but the benefits of doing so has been recognized and is something that infrastructure clients are working on. In the case of Oil & Gas projects, clients reflect that they have systems in place to see past and present safety challenges on similar projects. However, an interesting outcome regarding this role, is that it seems that contractors do not receive this kind of information because they still see it as the ”missing piece”. In the risk identification process a role that the client needs to play is to identify risks by consulting with workers hired on ongoing similar projects (Ma, 2006). In practice, it was observed that although oil and gas clients do indeed consult workers hired on similar projects or any expertise required without hesitation when it comes to infrastructure clients, they recognize the importance of consulting workers and ground level staff yet do not consult workers in the risk identification process. This disparity between the pre-construction phase and the construction phase on infrastructure projects at times leads to a HSE Plan that fails to address risks specific to the project.

5.2 Design

One of the key roles that clients need to execute in this phase is ensuring that the design team does not violate related bylaws set by regulatory bodies (Chunxiang, 2012). It was observed regarding this role that the responsibility of carrying it out is transferred from clients to consultants. Another role that has been recognized as an important one for clients to execute is to establish with all stakeholders, the practices required for risk assessment and recording risks (WorkSafe Victoria, 2017). It was observed that, in both oil and gas projects and infrastructure projects the risk assessment and recording process

is generally performed internally by the involved stakeholders. However, the results present an efficient way of carrying out this role, which is by establishing risk assessment and recording practices based on the quality of practices developed by the contractor or client. Essentially what this means is that whosoever practices are better, the whole project team must follow those practices. The design stage is crucial as it effects the whole life-cycle of a project, therefore, clients must consider the future stages of the construction project. This role is executed by Oil & Gas clients by involving a technical expertise that can push the design team to consider the safety of future stages of the construction projects. However, when it comes to infrastructure clients there seems to be a lack of health and safety specialists in the design phase to execute this role. The client should be responsible to make sure that the design team submits a hazard free designs considering the nature of the project as he is the most informed regarding the project environment early on in the project (Toole et al., 2017). The lack of safety specialists on infrastructure projects also hinders the proper execution of this role, which infrastructure clients are working on. Clients can implement the concepts of PtD and DfCS to set higher bars for safety (Gambatese et al., 2005). Through the interviews what could be derived from this role is that infrastructure clients are implementing these concepts more and more. Although this is the case, they are not executed completely due to resistance from contractors and the constant need to remind design teams to implement PtD and DfCS. In the case of oil and gas projects it was observed that although clients do insist on PtD and DfCS there is a lack of transparency with the transfer of information to design and construction teams.

One of the outcomes that was unexpected, but proves to be beneficial is the execution of two-phase contracting. This was bought up by clients and contractors on infrastructure projects. They expressed their desired shift to this type of contracts and mentioned that this shift can lead to better safety performance. The main benefit of this approach is that the client and contractor are in the project from the beginning therefore the designs are developed together and from a risk perspective the allocation of safety risks is done in a better manner.

5.3 Procurement and Tendering

An important aspect of this phase is the selection of a contractor, and to do so the client must include requirements in the tender documents to assess tenderer's knowledge (Toole et al., 2017). In regards to this role an interesting prospect is presented, which is to assess the tenderer's knowledge on project by providing specific safety challenges and to look at how the contractor deals with them rather than basing the decision on generalized safety practices. In the selection process a common award criteria has recognized to be TRIR and past experience. However, when it comes to infrastructure clients practitioners reflected that they are not able to take these into account as they are restricted by tender regulations. But when infrastructure projects can be awarded based on sustainability criteria why can't they be awarded based on safety criteria?

Despite the inclusion of stringent safety clauses in the tender documents, there is always a chance for non-compliance. Due to this it is important for the client to include a clause in the tender documents explaining that non-compliance to safety requirements can lead to termination of the contract (Chunxiang, 2012). However, in practice clients mentioned that the consequences of non-compliance cannot be that severe due to the safety competency gap between the client and contractor. This is an interesting observation because in the process of reflecting on different roles contractors said the same thing about their clients. The last step before going into construction phase is contract negotiation, it is important for the client here to address safety matters (Chunxiang, 2012). There were differing opinions when it came to the detail at which safety is considered during contract negotiation where Infrastructure clients and contractors reflected that safety is often not considered in the contract negotiation and Oil and gas reflected otherwise. However, a key point that almost all participants noted was that because the staff on site is completely different from those who negotiate contracts they can always see safety challenges persist going into the construction phase.

5.4 Expert Validation

As mentioned in section 3.5 the discussions were shared with all nine interview participants to obtain their opinion and to incorporate any necessary changes while developing the recommendations to infrastructure and oil & gas clients. Of the nine interview participants only Contractor 1 (INF) replied with certain comments. The main comment from Contractor 1 (INF) was that knowledge sharing,regarding safety issues in the past, on infrastructure projects is occurring more and more. The contractor also shared pamphlets elucidating how this is done. Although, a positive direction can be seen in regards to clients sharing safety challenges with the contractor, it can be seen that the pamphlet only acts as a summary of the incidents that occurred and not detailed information about the incident that is shared through a database. This is not to undermine the effort of clients to share safety challenges with contractors, infact it is a great stepping stone towards a more complete knowledge sharing platform.

6

Conclusions and Recommendations

In this section of the report the researcher will go back and answer the main research question and the sub-research questions. This section will also provide recommendations to clients based on the results, discussions, and expert validation.

6.1 What is the relationship between client involvement and safety performance on construction projects?

This research initiated with a literature study to comprehend how safety performance can influenced by the involvement of clients. Prior to determining this influence it was important to determine the current state of client involvement in safety. It was determined that the present condition of client participation in safety in the construction industry demonstrates a lack of motivation among construction clients to actively participate in safety initiatives (Musonda et al., 2013). This is the case despite safety regulation established like the EU Directive 92/57/EEC, later incorporated into the working conditions decree (Arbeiddsomstandighedenbesluit), that establishes the responsibilities of the client (Aires et al., 2010). However, clients have progressively recognized that they can't distance themselves from the legal responsibilities associated with worker's injuries, financial and reputational damage (Musonda et al., 2013).

Considering the increased interest of clients to fairly distribute safety responsibilities between them and contractors and collaborate on safety issues, the research goes into identifying what the effect of this involvement can have on safety performance. Gibb et al. (2014) recognizes that as initiators of projects many decisions that clients make can impact safety performance, including allocating project budgets, setting project timelines, establishing project objectives and key performance indicators, contracting strategies, and project team members. Therefore it is important for clients to consider how safety performance can be improved in each of the decisions they make. Moreover, it was determined that construction projects in which clients actively participated in safety related-activities experienced a notable reduction in injuries (Kikwasi and Smallwood, 2016). Lastly, due to the fact that the ability to effect safety performance gradually decreases through the course of the project and because clients have the greatest leverage in the pre-construction phase, this phase was selected to further determine the roles that clients should execute to improve safety performance (Åsgård and Jørgensen, 2019).

6.2 What are recognized best practices for construction clients during pre-construction phases to improve safety performance?

The literature review continued with the aim of answering this question and revealed a total of forty three safety specific client pre-construction roles, which were segregated into the different pre-construction phases: Planning, Inception, and Feasibility; Design; and Procurement and Tendering (Raza et al., 2022). The planning, inception, and feasibility phase presented 12 roles, the design phase presented 12 roles, and the procurement & tendering phase presented 19 roles that the clients should portray.

In the planning, inception and feasibility phase the clients role begins with starting the project off right and establishing a zero-injury objective at site (Lopes, 2011). Then comes in the roles associated with early risk identification in which it is crucial to include safety related risks and to identify general safety issues (Toole et al., 2017, WorkSafe Victoria, 2017). Literature further highlights the need to include appropriate stakeholders in the risk assessment process including the consultation with workers hired on

similar projects (Fleming et al., 2007, Ma, 2006). To improve the risk assessment process WorkSafe Victoria (2017) suggests the identification of safety specific issues from prior experience and similar projects. The next step and role for the client is to document identified risks for further teams and to prepare for the upcoming phases of the construction process (WorkSafe Victoria, 2017). With the completion of the early risk identification and documentation it provides the opportunity for clients to consider the safety related risks and if necessary redefine the corresponding part of the project (Votano and Sunindijo, 2014). The clients should be commencing the preparation for the upcoming phases by including safety related specifications in the project objectives, project brief, and design requirements (Saifullah and Ismail, 2012). In addition to this it was revealed that clients should hire a competent design team for efficient risk assessment and mitigation, appoint a safety team, and specify how safety is to be addressed in tenders (Toole et al., 2017, Ma, 2006).

Moving into the design phase the client roles can be split into the responsibility of clients to select safe designs and to conduct an efficient risk assessment process. In the process of selecting safe designs it is crucial that the client checks on design changes by reviewing the design documents and to ensure that safety matters are up to date (WorkSafe Victoria, 2017, Chunxiang, 2012). It was revealed through literature that it is also crucial that client takes into consideration regulatory bodies and make sure that the design team does not violate any bylaws set by them (Chunxiang, 2012). Literature also reveals the importance of setting higher bars for safety through the implementation of PtD and DfCS and urges clients to ensure that designs include information about safety in constructability, maintenance and use (Gambatese et al., 2005, WorkSafe Victoria, 2017). Lastly, to enable the selection of safe designs, clients should make sure that the designs consider safety issues as required by the nature and type of project (Chunxiang, 2012). Clients should be responsible for guiding the risk assessment process in the design phase and literature reveals that they should provide guidelines to the design team for identifying and designing out safety risks (WorkSafe Victoria, 2017). Moreover, literature articulates that the client plays an important role in involving stakeholders in the risk assessment process and states that the client should take every effort for the identification of safety risks in design and categorize them based on their impact on stakeholders (WorkSafe Victoria, 2017). This can only be done by involving the relevant stakeholders and having frequent interactions with the aim of realizing safe designs, sharing knowledge related to safety risks to all stakeholder, and establishing with all stakeholders the practices required for risk assessment and recording (Lingard et al., 2020, Abudayyeh et al., 2006, WorkSafe Victoria, 2017).

The client roles in the final pre-construction phase, procurement and tendering, can be split into three major roles: preparing tender documents, selecting a safe contractor, and developing the contract. Looking into the preparation of tender documents, literature reveals that the client should include safety requirements in the tender documents to assess tenderer's knowledge about safety, should involve a special clause about safety performance, should require tenderer to produce OHS plan, should involve a clause stating non-compliance to safety requirements can lead to termination, should ensure that safety is an item in the project cost estimate, and should detail the item covering safety matters is given due consideration as other items (Toole et al., 2017, Votano and Sunindijo, 2014, Kikwasi, 2008, Chunxiang, 2012, Abudayyeh et al., 2006, Ma, 2006). Taking into consideration the responsibility of clients to select a safe contractor literature reveals that this can be done by the client by evaluating the contractor's total recordable injury rate, by making room for a financially stable contracting firm, by considering a tenderer who responded well to safety matters, by bringing in the knowledge of the tenderer to review the safety risks identified by the design team, by approving the resumes of key safety personnel of the contractor, by evaluating the contractors commitment towards safety (Zuofa and Ocheing, 2017, Ma, 2006, WorkSafe Victoria, 2017, Musonda et al., 2013). Lastly, the client is responsible for the development and finalization of the contract, here literature suggests that the client should establish safety requirements in the contract other than legislation, should address safety during contract negotiation, and must establish the safety responsibilities of the parties to the contract (Zuofa and Ocheing, 2017, Chunxiang, 2012, Musonda et al., 2013).

6.3 What role do infrastructure and oil & gas clients play during the pre-construction phases to improve safety performance, from the perspective of clients and contractors?

From the roles determined in the previous section the research went into the semi-structured interview phase to reflect on the roles specifically in infrastructure and oil & gas projects. The perspectives of both clients are contractors was obtained on 43 different pre-construction client roles of which 11 roles were further expanded in the later stages of this research. The reason for a specified focus on these roles is due to the different ways in which the different clients execute them. Meaning that either the particular role was not conducted by one of the two clients or that it was executed differently by the two clients leading to insights into how these roles can be executed more efficiently. The first role that was expanded on is establishing a zero-injury objective, the different participants reflected on this role and it was determined that in deviation from literature that in fact clients should establish safety objectives that are stricter than zero-injury. An example of this is mentioned by oil and gas participants as establishing objectives based on near misses and incidents allowing clients to take a proactive approach towards safety. In addition to this another role that is reflected on in detail is the redefinition of the scope of the project based on the risk identification, to which practitioners mentioned that this is not conducted efficiently by clients because they do not involve contractors early on. Another important role that practitioners reflected on is identifying the safety specific issues from prior experience and similar projects. It was observed that on infrastructure projects this kind of knowledge sharing doesn't occur whereas on oil and gas projects it does occur but with a lack of transparency with the contractor. Along with identifying safety risks from prior projects it is also important to consult workers hired on ongoing similar projects. It was seen that this does occur on oil and gas projects but not on infrastructure projects.

Moving into the design phase a significant role that was expanded on is to establish with all stakeholders the practices required for risk assessment and recording. Although, the different practitioners mentioned various ways of executing this role the research found a particular method mentioned by an oil and gas client effective. This method entails the evaluation of the client's and contractor's risk assessment processes and the selection of the the practices that are most strict. A fundamental safety role that the client should execute is the verification of whether safety of the future stages of construction are considered in the design phase. It was observed here that on infrastructure projects there exists limited number of safety experts to carry out this role. The lack of safety experts not only hinders this role but also restricts the development of hazard free designs considering the nature of the project. With the aim of establishing higher bars for safety it is the prerogative that clients introduce to PtD and DfCS, in reflection of this practitioners mentioned that there is still hesitance from infrastructure contractors and design teams to implement this role. In the case of oil and gas projects these concepts seem to be taken into consideration but lack transparency in sharing this information to execution teams.

One of the key roles that clients need to play to execute a safe project is the selection of a safe contractor and to do so the client must include requirements in the tender documents to assess the tenderer's knowledge regarding safety. The interviews brought out a way in which this can be done effectively, which is to assess the tenderer's knowledge on the project by providing specific safety challenges and challenge the tenderer to address them. Another essential role that is mentioned in literature is addressing non-compliance to safety requirements by terminating the contract. However, it was observed that this is hardly done in practice due to the competency gap that exists between the client and contractor with each party blaming the other about low safety competency. Lastly, a vital client role before going into construction is discussing safety in detail during contract negotiation. In reflection of which almost all participants mentioned that the staff on site are completely different from those who execute the project leading to increased safety challenges during construction.

6.4 How can construction clients optimize their roles during pre-construction phases of infrastructure projects and oil & gas projects to enhance safety performance?

Having answered all the sub-questions in the previous sections of this chapter, it is important to attempt to answer the main question of this research. Considering the findings from literature, the interviews, and the expert validation it can be seen that construction clients can indeed improve safety performance on their projects by performing certain roles in the pre-construction phases that articulated throughout this research. However, certain changes and optimizations need to be made, which can be seen below:

1. Establishing a zero-injury objective: Infrastructure clients can learn from Oil & Gas clients by establishing stricter safety objectives.
2. Risk assessment process: Clients on both types of projects can learn from literature and see the benefits of involving the contractor earlier in the project.
3. Knowledge Sharing: Infrastructure clients can learn from Oil & Gas clients about identifying, recording, and sharing of safety challenges faced on prior similar projects. However, both types of clients need to ensure the transfer of this knowledge to relevant stakeholders.
4. Considering safety of the future stages of the project during development of designs: Infrastructure clients can learn from Oil & Gas clients by including more safety specialists equipped to review whether designs take the future stages into consideration.
5. Including on-site workers in contract negotiations: the results reveled that both types of clients do not include on-site workers in the contract negotiation phase. This is something that they need to work on as the on-site workers will be the ones executing all the safety procedures.
6. Involving the contractor early on in the project: Contractors from both types of projects expressed their interest in being involved earlier in the project, allowing their expertise to be involved. Infrastructure clients recognize this and moving to contracting methods like two-phase contracting. Oil and Gas should also consider project delivery models that allow for this.

These six points have further been elaborated in the following section where the researcher provides recommendations for construction clients on how they can optimize the way they execute their current roles with the aim of improving safety performance on oil & gas and infrastructure projects.

6.5 Recommendations for Clients

From the interviews contractors from both types of projects articulated that they would like to be involved in the project as early as possible. It was seen that clients involve contractors from the design phase despite the expertise that contractors can contribute in the planning phase. Therefore, the first recommendation to both oil and gas clients and infrastructure clients is to include contractors from the planning, inception, and feasibility phase itself. One way in which this can be done, as articulated by practitioners working on infrastructure projects, is to use the two-phase project delivery model. The two-phase model provides the opportunity to conduct a detailed risk assessment and allows for a collaborative approach towards developing design. Moreover, the two-phase approach allows the contractor to provide his expertise to the client. These benefits come at no great cost as the client still has the option to still choose another contractor to enter the next phase, which will be the execution team. If in case the client decides to go for another contractor, through the first phase the client would have already portrayed all the necessary roles in the planning, inception, and feasibility phase and design phase and would just have to portray the necessary roles in the tendering and procurement phase. Looking in more detail in the tendering and procurement roles it can be seen that the job of the clients reduce because in this phase they wouldn't need the assistance of the tenderers in validating the designs, the focus can shift to selecting a safe contractor against requirements established in the first phase.

Once the client involves the contractor early on the researcher recommends the formation of a safety committee that includes members from both parties. The essence of this committee is to approach safety together and work as ”one safety team” for the project. The safety committee will be used as the vehicle by the researcher to recommend improvements to the safety specific pre-construction roles of oil & gas clients and infrastructure clients. However, before going into the specifics of the role that the safety committee will play it is important to note that the safety committee should be given the power to make decisions on all things safety. If this power is not provided to the committee, the establishment of one becomes redundant and can result in a delayed decision making process. The committee should be made up of one neutral safety expert appointed as the head of the committee and will be the final decision maker, having this neutral member helps in avoiding the clear blame game that exists on both oil and gas and infrastructure projects. When it comes to the members from the contractor and client they need to basically involve a range of safety experts from different phases of the construction project including technical experts and safety managers.

The first role that the safety committee should execute is establishing safety objectives for the project. The researcher recommends establishing stringent safety objectives, like seen on oil and gas projects. It is important for the committee to establish pro-active safety objectives looking at safety as an ”iceberg” to consider the near-misses and incidents and not look at safety after the fact. Now that the safety committee will be able to establish the safety objectives for the project it is similarly important that it establishes performance indicators against these objectives and must assure that these indicators include leading indicators to continue that pro-active approach towards safety. One of the issues that was raised in the interview process is that clients (specifically mentioned about oil and gas clients) establish strict safety objectives, as recommended, but that these seem to be just on paper and not realized in practice. The benefit of having a safety committee that includes both parties such that contractors can contribute to the safety objectives being established for the project and reflect on if the objectives are realistic and achievable.

Following the establishment of safety objectives the next major role that the safety committee should portray is undertaking the risk assessment process. Even before beginning of the risk assessment process it is important that the committee establishes the procedures for risk assessment, risk recording, and transferring of information. To establish these procedures the researcher takes inspiration from oil and gas projects, where risk assessment and recording practices are established based on which party has better procedures. Whosoever risk assessment procedures are clearer and more detailed the project should follow those procedures. The safety committee leader must make a decision on this. Of course this may lead to some back and forth but the researcher believes that this kind of debate is good to come up with the most efficient risk assessment and recording practices. In addition to this one of the complaints from contractors and clients alike is the lack of transparency in sharing information, the safety committee also helps with avoiding this because they are coming up with the information together therefore there is no question of lack of transparency. In addition to this, an important role that was recognized by literature is that the clients should verify whether the design team is taking into account the site conditions and the nature of the project during the development of designs. Practitioners, more specifically infrastructure practitioners, mentioned that they have limited safety specialists and therefore this role is neglected but with the help of the safety committee and the safety as one team approach there would be more specialists (both contractor and client specialists work as one team so more both in quantity and quality) to make these informed decisions.

One of the important roles that the safety committee should execute is developing a knowledge sharing platform that contains a database of the safety challenges that have occurred on past similar projects to assist in the risk identification process. The knowledge sharing platform can be developed based on existing databases on oil and gas projects, however, it is important this platform is made available to a wide range of stakeholders and not limited to the just the clients as is the case now. The knowledge sharing platform should indeed be established in such a way that it is accessible to all construction industry participants, that way it provides the opportunity to learn from the safety challenges faced across the industry leading to a safer environment in the industry.

Lastly, one of the major complaints from practitioners from both types of projects is that there is no

on-site workers during contract negotiations. To overcome this clients should include at least one team member from site who can be called a safety leader that provides his inputs during the formulation of the contract and HSE Plan to reflect on the practicality of administering the contract from a safety point of view. Moreover, through the establishment of a safety committee there are more chances of fair distribution of safety roles between the client and contractor reducing the chance of non-compliance. The contract must still take it into account that non-compliance can happen but with the safety committee the terms for non-compliance can be as strict as termination, which is not the case on both type of projects now, because now both parties function as one team and can assist in meeting the safety requirements established at the beginning of the project.

7

Strengths, Limitations and Future Directions

In this final chapter of the research, the strengths of the research will be explored for both the construction industry and for academics. It will further elaborate on the limitations of this study, with a specific focus on the method used. Lastly, potential ways of advancing this research will be explored.

7.1 Strengths

The strengths of this research are two-fold because they present valuable inputs to the construction industry and to the academic sphere. This research contributes to existing literature by focusing on the external factor of safety performance that hasn't been covered in enough detail. Moreover, this research focused on identifying safety specific client roles during the pre-construction phases. Identifying these roles and cross checking them through the interviews allows for a re-consideration of whether current literature in fact reflects the best client practices from a safety standpoint during the pre-construction phases. One such example could be the role "To establish a zero- injury objective at site"as mentioned in literature but when reflected by practitioners it could be seen that the objective should be more strict and should establish objectives more towards near misses and incidents, having a pro-active effort towards safety. The research also added a comparative element by applying generally identified pre-construction client roles from literature to the contexts of oil & gas projects and infrastructure projects. A benefit of using this approach was that the best practices from both industries could be used to come up with recommendations that can be generalized to most construction clients, of course with some adjustment based on the type of the project. Lastly, this research takes a multi-perspective approach by interviewing both clients and contractors. This approach, the researcher believes, is helpful because it provides the opportunity for clients and contractors to understand each other and be on the same page regarding their safety objectives.

7.2 Limitations

It is important to consider the limitations of the research as well to enable future researchers to keep these limitations in mind when designing future research. The first limitation is the limited number of participants that were interviewed for the research. The challenge with this is that it makes it difficult to obtain a wide range of perspectives limiting the generalizability of the results. Moreover, certain participants represented the same organization, which could mean that the results reflect the safety practices of these particular organizations and not those of the industry. To try and overcome these limitations, during the interviews, the researcher tried to ask questions in a way that the interviewee can provide an answer based on their overall experience rather than from a particular organization. The next limitation comes in the form of social-desirability bias, which states that respondents will answer according to what they think is favorable to others. Especially, when it comes to a sensitive topic like safety there are chances that the participant is hesitant to share true facts effecting the validity of the results. To overcome this limitation the participants were informed that all the information will be kept confidential and that the names of the participants will be kept anonymous. Lastly, due to the amount of literature read in the earlier stages of the research it is possible that the researcher experienced an expectancy effect, which states that the interviewer can steer answers based on the answers he expects. This limitation was overcome by developing an interview guide to use as a backbone during the interviews. Despite this it was not completely possible to overcome this barrier due to the free flowing nature of semi-structured interviews.

7.3 Future Directions

The research is just a starting point for exploring the role of clients to improve safety performance on construction projects and provides the opportunity for future researchers to expand the research in various directions. First and foremost, it was seen in literature that majority of construction safety research focused on the construction phase. To explore the other stages of the construction project life-cycle this researcher choose the pre-construction phases, however, future research can focus on the post-construction phases like operation, maintenance, and demolition. The current research focuses on the Dutch construction industry but forms a foundation to apply the research to different countries, allowing more generalizability to the construction industry around the world. The research, through its comparative element, explored if and how clients on infrastructure and oil & gas clients execute safety specific pre-construction roles. Future researchers can design their research in such a way that more types of construction clients are included in the research. This research included nine participants, future researchers can include more participants that represent a wide range of organisations in order to obtain a better understanding of the safety practices of the industry as a whole. In addition, this research includes perspectives of clients and contractors but future research can include other important stakeholders like consultants, safety regulators (for example The Safety Inspectorate) and can examine their role in improving safety performance. The research takes a holistic approach and identifies a number of roles in each of the pre-construction phases, but future researchers could focus on specific roles and expand on how they should be executed to improve safety performance. This research took a qualitative approach to determine construction clients (Infrastructure and Oil & Gas), future researchers could use qualitative methods like Q-methodology to rank and determine the importance of each role. Finally, the research looks at optimizing the role of clients during the pre-construction phase to improve safety performance, future research can look into determining how these roles influence the different components of safety performance (safety compliance and safety participation).

Reflection

The completion of this masters thesis marks the completion of my masters degree in Construction Management and Engineering. The journey that I have gone through in the completion of this masters thesis has been one that is challenging yet extremely satisfying. Moreover, this research ignited an interest in safety on construction sites that I previously did not have. Exploring various topics regarding safety management led me to a range of topics, which my supervisors patiently listened to. From which they could guide me into selecting a topic that is interesting to them without losing the essence of the topic that i was interested in researching.

However, conducting a research at this level was something that i never have done before as a researcher, leading to certain unanticipated challenges. Fist and foremost, I conducted this research without any collaboration from any organization leading to difficulties in arranging interviews. However, with the help of my second supervisor Ir. Hans (J.P.G) Ramler I was able to arrange some interviews. The other interviews were obtained by the use of snow-ball sampling and through Linked-In, this was a rather slow process and led to delays in my research. If i were to do the research from scratch I would have started looking for interviews right after my topic was approved to enable timely completion.

Another challenge that I faced was with the structuring of my research. This started with the literature study itself, i was lost in literature due to the large amount of literature regarding construction safety management. Moreover, I decided to write/report the research in a sectional manner restricting a holistic view of the research. However, with the help of my supervisors and their feedback during the progress meetings I was able to come back and understand how to structure my research better. This was extremely helpful especially when writing my discussions and recommendations as it allowed to me to take into account the research in entirety and allowed me to reflect on each of the steps in the research.

At the commencement of this research I had interactions with various professors in the TU Delft, which led to the formation of this topic. However, from the interactions I had started with a bias that oil and gas clients perform their safety roles better than infrastructure clients and it had taken some time for me to get out of that bias. Continuing this bias would have led to different results but with the help of my supervisors I was able to mitigate this bias and take a more neutral approach, which I believe has led to more fruitful recommendations that were formulated by considering insights from both types of clients.

Lastly, and I cannot stress this enough I learnt through this research that it is important to put your thoughts down on paper and actually write. For a long period, almost until progress meeting two, I did not put enough into writing although what I wanted to write was in my head. This led to an additional progress meeting that was not planned and played a part in the challenges I had with the structure of my report. So if there is one thing that I would recommend to future masters students taking this journey is to write, write, and write. All in all this thesis journey was a challenging one but also one that has taught me a lot not only about the subject of the research but also about how a research should be conducted. Moreover, with the completion of each step of the research I felt more and more validated regarding my skills and became more confident which I believe will play a crucial role in my professional career that is to come.

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8

Appendix

8.1 Interview Questions

8.1.1 Planning, Inception, and Feasibility

1. How important is safety performance as a performance indicator to you as a client?
   (a) How is a “zero-accident” objective established right from the initiation of the project?
   (b) At which stage is safety introduced in a typical project?
2. Can you describe the process that clients use to identify risks during planning and feasibility checks?
   (a) Who would be the appropriate stakeholders to be involved in the process and how are they involved?
   (b) How are general safety issues identified within the planning phase?
   (c) How is knowledge regarding safety-specific issues from prior experience and similar projects used to identify risks?
   (d) How can consultation with workers hired on similar on-going projects benefit in the risk identification process?
   (e) How does the risk identification process affect the scope of the project (redesigning)?
3. How are the identified risks documented and transferred to the design and construction team?
4. How is safety considered during the preparation of the project brief, project objectives, and design requirements?
5. What is taken into consideration when hiring human resources, in regards to safety, for all stages of the construction project?
6. What considerations are taken into place while hiring the design team in relation to their ability for risk assessment and consequential identification of and response measures against potential hazards?

8.1.2 Design

1. What role do clients portray in regards to accepting safe designs?
   (a) How does the client ensure that all OHS matters are up to date in design?
   (b) How does the client ensure design changes are updated in designs?
   (c) How do you ensure that designs don’t violate related bylaws set by regulatory bodies to allow for swift approval of designs?
2. How does the risk identification process work during the design phase and what role does the client play?
   (a) What guidelines do you provide to design engineers for identifying and designing out risks?
   (b) How often do you interact with stakeholders with the agenda of safety for the realization of safe design?

   (c) How do you share your knowledge related to risks and OHS with stakeholders and by doing so how can you ensure that all related risks are listed?
   (d) How do you establish with stakeholders the practices required for risk assessment and recording risks?

3. How are future stages of the construction process already considered in relation to safety early on in the project?
   (a) How can the implementation of PtD and DfCS set higher bars for OHS?
   (b) How is the constructability, use, and maintenance considered from a safety standpoint during design?

4. How do you ensure that the design team considers OHS issues as required by the nature and type of project?

8.1.3 Tendering and Procurement

1. How are your safety considerations during the development of tender documents?
   (a) What OHS requirements are included in tender documents to assess the tenderer's knowledge on OHS?
   (b) How is safety performance addressed in the tender documents?
   (c) To what detail is the item covering OHS addressed compared to other matters?
   (d) How is the costing for safety covered in the tender documents, is there a separate item for OHS?
   (e) How is non-compliance to safety addressed in the tender documents?

2. What documents are expected to be submitted by the tenderer in relation to safety during the tender process?

3. How is a safe contractor selected?
   (a) What role does a contractor's TRIR and past experience play in selecting a safe contractor?
   (b) How does selecting a financially stable contractor affect the safety outcomes of a project?
   (c) How can you assess who responded well to the clauses on OHS matters?
   (d) How do you evaluate the tenderer's commitment towards safety?

4. How is the knowledge of the tenderer in regards to the risks identified during the design brought on?

5. How is OHS addressed during the contract negotiation process?
   (a) How are minimum safety requirements other than legislation addressed in the contract?
   (b) What documents are contractors expected to include in the contract?
   (c) How are the OHS responsibilities of the parties addressed in the contract?

8.2 Invitation Letter

TU Delft

Invitation to participate in Msc Thesis Interview

Enhancing safety performance in the construction industry by optimizing client roles during pre-construction phases

Dear Practitioner,

My name is **Rohith Munnamgi**, and I am currently pursuing a Master's degree in Construction Management & Engineering at TU Delft. As part of my graduation research with **TU Delft** under the supervision of **Prof. dr.ir. P.H.A.J.M van Gelder**, **Assistant Prof. Karolien van Nunen, and Ir. Hans (J.P.G) Ramler**, I am conducting an in-depth study to analyse what role clients play to improve safety performance on construction projects with a focus on pre-construction activities.

The main objective of my research is to determine how clients are involved in regards to safety during the pre-construction phases and to compare the practices followed on two types of construction projects: Oil & Gas and Infrastructure. Your expertise and insights regarding the construction process and more specifically the safety aspects, could contribute significantly to this research.

Therefore, I would like to invite you to participate in an interview that will explore your perspective on:

1. The pre-construction phase of construction projects;
2. How a context where safety performance is established in these phases; and
3. The role of the client in achieving no. 2 ;

The interview will be conducted by me, will last approximately 60 minutes. Participation is entirely voluntary, and I will be happy to schedule it at a time that suits you .

I propose that we conduct this interview digitally via Microsoft Teams, or in-person, the option which suits you the best. Prior to the interview, I will seek your permission to record our meeting, purely for the purpose of accurately transcribing it. Please be assured that the recording will be deleted post-transcription and your responses will be fully anonymized in my research.

Following our discussion, you will receive a transcript of our conversation within three weeks, and I will request your approval of its content to ensure accuracy.

I am confident that your insights and experiences will greatly enrich this research and potentially influence the strategies that will developed to optimize client roles during pre-construction phases of construction projects to enhance safety performance.

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8.3 Interview - Results Table

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
1	To establish a “zero injury” objective at site	Contractor 1 (JF): ”Our infrastructure clients are mostly governmental agencies, therefore, they don’t set the objectives for safety we do because they are not that competent on safety.” Contractor 2 (TM): ”I do believe that clients see safety performance as an important indicator for success but I question the quality of those indicators because they are lagging indicators like zero-injury, TRIR, etc.”	Contractor 1(PK): ”The client does establish such objectives but I believe it is only a façade, there are posters everywhere but often I don’t think safety is a priority” Contractor 2 (SEBI): ”Our clients are way beyond the objective of zero-accidents/injuries they are now at the stage of zero events and near misses”	Client 1 (RJS): ”Well as RWS we struggle looking at safety performance and that has to do with the fact that we are a governmental organization so we must follow tender legislation to bid making it difficult to focus on safety performance” Client 2 (FS): ”We may not have an outright zero-accident (injury) objective but at the beginning of any project we set our safety ambitions with the contractor so that we can work as one safety team and develop a combined safety culture”	Client 1(HdV): ”In terms of Shells objective towards safety in the initiation of the project we follow a pyramid of safety, which indicates that we should look at safety like an iceberg and consider the near misses and not just pay attention to the accidents when they happen.” Client 2(FM): ”The company’s ethos is no accidents and no harm to anyone. But does this ethos reflect in practice, to be honest maybe not 100% but we make our best efforts to tackle all safety challenges that come at us through the different stages of the construction process.” Client 3(DD): ”We achieve a zero-accident objective by implementing a robust management system in safety and communicating our safety policy to all stakeholders is a key aspect to put together a stepping-stone to achieve zero accident strategy.”

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
2	To include appropriate OHS risks into risk assessment process	Contractor 1: "For me as a safety professional working for the contractor this early on in the project so I can't tell about the risk assessment process at this stage" Contractor 2: "We as contractors are not involved early enough unfortunately. It would be nice to be involved early at the sketch design phase. We will mostly be involved in the implementation design, which happens after the final design."	Contractor 1: "Safety starts at the design phase for me and in this phase I will definitely include OHS risks into my risk assessment process, I can't comment much on the client's risk assessment process" Contractor 2: "We as the HSE team of the EPC contractor are included in the design phase. The clients involving us earlier on the project helps us a lot on eliminating risks that can be found in the construction phase."	Client 1: "There are two phases of risk assessment one which begins at the idea generation phase till the bidding phase and the other the design and construction phase. In this risk assessment process all kinds of risks will be identified including safety risks" Client 2: "The safety officer is involved right from the beginning to assess alternatives and determine which method would be most safe"	Client 1: "So before we go to the market with a tender my job was to make a risk visual of the project. I would at this stage conduct all kinds of studies as required by the Hazard Affect Management Process." Client 2: "At the concept stage we would have technical safety experts looking at design safety but as we progress we will involve consultants working for us with the EPC contractor, all working towards identifying safety related risks" Client 3: No Comment pertaining to this role
3	To conduct an adequate risk assessment with appropriate stakeholders	Contractor 1: No comment pertaining to this role Contractor 2: No comment pertaining to this role	Contractor 1: "As far as we are concerned we would involve clients, notified bodies, insurance agents, technology vendors, patent holders, basically whatever expertise we would need to help in the risk assessment process we would involve." Contractor 2: No comment pertaining to this role	Client 1: "We would have a project management team consisting of the project manager, the technical manager, the health and safety expert, and the contracting manager who would all be involved in the risk assessment process." Client 2: "I would basically involve any party that could be affected by the project that I am working on in the risk assessment, albeit to degrees"	Client 1: "Stakeholders that I would include in the risk assessment process would be External affairs (social), Legal (to ensure compliance), project manager, project director, all stakeholders will be within my company itself at this stage." Client 2: "You will have a technical team looking at design risks and you will have the project risk manager looking at non-technical risks, whom would be responsible for involving any external stakeholders." Client 3: No comment pertaining to that role

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
4	To identify general safety issues within the planning phase	Contractor 1: ”I really can’t speak to whether the client identifies safety issues but we would like them to and then we can take it forward from there. If they don’t conduct it then we start from scratch” Contractor 2: ”It depends on the kind of project that it is, if the client is responsible for the design we see that he does some risk assessment but if we are doing the designs they are hardly involved”	Contractor 1: ”In this stage it is important for the client to be involved as well because they need to provide input because the basic concept of a risk inventory session is that you have knowledgeable people around.” Contractor 2: ”I’m not sure before we are involved but from the stage we are the client expects us to take a leading role in identifying safety related risks”	Client 1: ”The first thing we do in regards to safety is to check if the contractor has really thought of safety when determining the work method.” Client 2: ”RWS has been building bridges, roads, tunnels, and water infrastructure for around 230 years and we continue to do similar projects so this allows us to have a standard risk database which can help in identifying the general safety issues.”	Client 1: ”The general safety issues are the first thing that we identify in the Hazard Identification process.” Client 2: ”In this phase when it comes to identifying and assessing safety issues there is no focus on operational safety challenges, the actual designs are just developed based off API or BS standards” Client 3: ”Considering safety-related risks during the risk assessment process in the initial phases of a project is crucial because it helps in Hazard Identification, helps comply with legal obligations, risk reduction, and allows Health and safety to be a top priority.”

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
5	To identify the specific safety issues from prior experience and similar projects while planning the project	Contractor 1: "This really depends on the client, we have worked with clients who are more advanced in sharing lessons learnt and others who don't bother" Contractor 2: "The sharing of specific safety issues from prior experience might exist slightly but I think the information is not sufficient. Additionally I would love them to share our information with other contractors, I believe this will make a much safer place."	Contractor 1: "It doesn't happen enough on oil and gas projects because this needs a vast amount of data but I believe this is the missing piece, feedback you get from experience can be forced upon team members to utilize this feedback, which is very valuable." Contractor 2: "Initially clients are reluctant to share safety challenges but in my experience when it comes to safety the client is often ok to share these prior challenges eventually when we state our experience so they are more comfortable to do as well."	Client 1: "I think in infrastructure that is something under development right now. I know in oil and gas they learn from incidents globally. They have that plan do act check circle that is completely implemented unlike on infrastructure projects. We are 20-25 years behind the oil and gas industry, in my opinion." Client 2: "RWS has a safety department what they do is have meetings with all the safety experts on different projects a couple of times a year which acts like a lessons learnt session and we share our experiences which can help to identify risks that may re-occur."	Client 1: "I have access to a database that informs me about every incident occurred on my company's project, which can then help me with the identification of risks on my project" Client 2: "The engineers tend to move from project to project, so there is a lot of knowledge being shared. The company conducts discipline specific annual forums for knowledge sharing." Client 3: "Safety challenges in similar projects we had will be carried out with thorough risk assessment and hazards analysis and identify the opportunity for improvement and addressing the risk mitigation plan as well as escalating those challenges with senior management for resolution and necessary decision making."

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
6	To identify the risks by consulting with workers hired on ongoing similar projects	Contractor 1: No comment pertaining to this role Contractor 2: No comment pertaining to this role	Contractor 1: No comment pertaining to this role Contractor 2: No comment pertaining to this role	Client 1: ”I think it is important to consult ground staff, especially toward the end of the design, what you see now is that one team prepares the HSE Plan but another is executing it. You can see a high number of risks in the HSE Plan that are not specific to the project.” Client 2: ”We don’t consult workers on similar on-going projects as early as the planning phase especially when it comes to workers on site but as mentioned below I am always in contact and learning from other RWS safety professionals working on similar on-going projects.”	Client 1: ”We will involve experts, which may as well be workers, at a requirement basis. If we need expertise to help us analyze a particular safety risk we will not hesitate to involve them.” Client 2: ”We will definitely consult workers hired on similar on-going projects in the risks identification process.” Client 3: No comment pertaining to this role

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
7	To document all the identified risks for contractors and designers	Contractor 1: No comment pertaining to this role Contractor 2: No comment pertaining to this role	Contractor 1: No comment pertaining to this role Contractor 2: ”I can’t comment much on how the client’s systems work but within our company we have a standard system of procedures which we then pass on to our subs that articulates what we expect to receive on a matter of safety, compliance. We do not necessarily have any standardized tools but the procedures are standardized.”	Client 1: ”With our company we have a risk management program so we’ve got one major database with all the project risks including safety risks, which is updated once every two weeks.” Client 2: ”We would document risks in a safety risk database, which we do on relatix. In the database the whole project and everything that is in the contract goes into and then we follow what we would need to send to the contractor.”	Client 1: ”We have SharePoint for that so every project you have a document management system. However, the difficult part within shell because this document system is so shielded so when you do a project with the contractor it is rare that the contractor is on the same share drive.” Client 2: ”We have nominated consultants that are knowledgeable on the risk assessment processes of our company and therefore we would require the contractor to hire one such consultant who can then not only guide the contractor on the documentation of risk.” Client 3: ”We maintain a safety risk register and the same is periodically reviewed for its risk mitigation measures and if required provide additional control measure to and implement those measures to prevent any incidents accidents by communicating the risk register and control measure to relevant stakeholders.”

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
8	To identify and design out safety issues and risks by redesigning corresponding part of the project	Contractor 1: ”Safety challenges can dictate the scope of the project. I mean like for example about working in water before, but you should just send the guy down a diver and we would just let him do the work. And now quite often you have to see if there’s other ways of doing work on the water without using a person because it’s very high risk work.” Contractor 2: ”Me as a safety professional working for the contractor am not involved early enough to be able to redesign aspects of the project, but by doing so we, as a project team, will be able to take the right decisions.”	Contractor 1: ”The client is usually not too familiar with the processes of re-assessing the scope of the project they often hire external consultants.” Contractor 2: ”Of course safety challenges affect the scope of the project. We always give the chance to change the design and the execution plan. Once we are done with final designs and before we mobilize on site everything is on the page for discussion. The client must be involved 100% at this stage.”	Client 1: No comment pertaining to this role Client 2: ”Yes the risk identification process affects the scope of the project. When we are designing the scope of the project we must evaluate it and our working methods based on whether it is possible to safely execute the work.”	Client 1: ”We start off thinking of methods of how it can be executed and only if we can conduct the work safely continue with the intended scope or else it must change.” Client 2: ”Absolutely the identification of safety risks can affect the scope of the project, where there are risks identified and quantified and our company has a criteria of 1*10-3 probability of failure and any risk that would exceed these figures would be not allowed and would require us to go back to the drawing board and change up the designs that we came up with.” Client 3: No comment pertaining to this role
9	Clients should be involved in including OHS related specifications and standards in project objectives, project brief, and design requirements.	Contractor 1: No comment pertaining to this role Contractor 2: No comment pertaining to this role	Contractor 1: No comment pertaining to this role Contractor 2: No comment pertaining to this role	Client 1: We have a health and safety specialist on board and the risk database is tracked, we develop a file that addresses construction, technical, which will be part of the tendering documents. Client 2: No comment pertaining to this role.	Client 1: ”It is included in the first paragraph of any project brief and would include the mission statement, goal zero, societal impact, etc. The contractor is made aware that the contractor is not alone but part of a community.” Client 2: ”Every contract we make will have safety criteria embedded in that contract or tender documents.” Client 3: No comment pertaining to this role

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
10	To hire competent designers for efficient risk assessment and consequent identification of and response measures against potential hazards	Contractor 1: ”We always share our risk assessment with the client and they can then make decisions where they would want us to have stricter restrictions on certain aspects, we can always work on that together.” Contractor 2: ”I think the client knows what kind of party they are working with so my company has a lot of construction staff that have the right qualifications to judge the safety aspects.”	Contractor 1: ”There is a whole prequalification part of the tender phase where they are assessing your capabilities, they come to our offices want to see our previous projects or books, procedures and they bring back this to the procurement team.” Contractor 2: ”They take into consideration our HSE stats and previous experience and we have always been leading in terms of HSE standards so much so that we set in place some of the standards.”	Client 1: ”I think this is something we still need to develop, so we have our project teams but in the planning phase we don’t have specific requirements for that other than the internal company requirements. In the new contracts we are setting such requirements but in the old contracts we expect the design team to bring out their expertise.” Client 2: ”The way we try to take into consideration other than the designer’s past experience and safety figures (TRIR, LTIF, etc.) we often share with the design team the risks that we are having a hard time assessing we would put our problem as a challenge to the market and make a decision on the best solutions that come up.”	Client 1: ”It is similar to the way we approach a main contractor so for the OE we do also a tender (one of the first things to do right after the idea). We ask the proposal to set up a team of consultants and we sit with them and ask for a document detailing how they will approach this projects in various aspects like finance, safety, etc. We ask them for a presentation in order to understand if we will be working with a mature team or not, we try to understand if safety is lacking behind.” Client 2: ”We will be asking for specific experience in certain areas but also we will take into account the demonstration of previous experience and how they handle risks. Also we tend to work with EPC contractors that we have worked with before that way we know how they conduct work.” Client 3: ”We look at Expertise (evaluate their experience in risk assessment and safety protocols), Collaboration (assess their willingness to communicate with the stakeholders of the project), Track record, and communication skills (ensures timely hazard reporting).”

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
11	To appoint safety team throughout project phases	Contractor 1: No comment pertaining to this role Contractor 2: ”In regards to the client’s safety staff we have a general manager and a safety officer who’s doing the inspections and observations weekly here. The general manager had left the job and hasn’t been replaced.”	Contractor 1: ”The client also has a very strong team, it is very annoying. If I zoom out on a European level you have a lot of clients that assume they have a lot of responsibilities and they do not fully understand the dynamics between the EPCM contractor and their responsibilities as a principal. They think they need to do a lot of stuff but that is not true. They only need to have this coordinator in design and execution.” Contractor 2: ”It really depends on type of project and number of people.”	Client 1: ”In the earlier contracts we had no requirements on HS staff, now we are really stating that for this kind of work we must have a safety specialist who has a high or medium amount of education on health and safety and legislation.” Client 2: ”We only hire our own safety staff and the construction company is responsible for hiring their safety staff. They have to have an industrial safety background or a structural safety background. We cannot have someone who is used to working on buildings because it is more complex with infrastructure and involves a different way of working.”	Client 1: No comment pertaining to this comment Client 2: ”During the hiring process of course we are looking at people with the right qualifications, the experience, and competency.” Client 3: ”The competency of the workers or any level of employees who are being recruited and their health conditions, educational background, proficiency in undertaking different languages and ability to learn from challenging atmosphere shall be considered. Experience and skill set to be also considered one of the criteria while selecting the resources.”
12	To specify how safety is to be addressed in tenders	Contractor 1: No comment pertaining to this role Contractor 2: No comment pertaining to this role	Contractor 1: No comment pertaining to this role Contractor 2: No comment pertaining to this role	Client 1: No comment pertaining to this role Client 2: No comment pertaining to this role	Client 1: No comment pertaining to this role Client 2: No comment pertaining to this role Client 3: No comment pertaining to this role
13	To give due consideration to safety issues identified from previous projects to avoid errors in present and future designs	Contractor 1: Addressed in 5 Contractor 2: Addressed in 5	Contractor 1: Addressed in 5 Contractor 2: Addressed in 5	Client 1: Addressed in 5 Client 2: Addressed in 5	Client 1: Addressed in 5 Client 2: Addressed in 5 Client 3: Addressed in 5

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
14	To ensure that all OHS matters should be up to date in design To keep check on design changes by reviewing design documents	Contractor 1: ”The clients are responsible for finalizing the design, all the different versions are shared with the client and at one point the client must finalize one version that will go into construction and they are involved in reviewing each of the versions that are shared with them.” Contractor 2: ”In general you want to see that a management of change will be executed but if it hasn’t and a design change comes out of the blue and we believe it is unsafe we have to stop work immediately and re-do the risk assessment process for the new designs.”	Contractor 1: No comment pertaining to this role Contractor 2: ”Throughout the design process as we conduct checkpoint confirmations/stage-gate reviews where we along with the client go over all the updates and ensure that all safety risks are taken into account and addressed through the designs.”	Client 1: ”We have a design coordinator on board, which is also mandated by legislation, who will be in constant touch with the design team, but in case of any changes that come up we will still require a request for approval.” Client 2: ”If there is a design change from the contractor they have to register that on relatix, if it is a scope change they have to come back to our technical tam and safety team to check all the changes from small to big to ensure everything is on track.”	Client 1: ”We have weekly meetings with the design team and we a document where we track all the enlisted items in the HAZID and I check if all these are covered by the design.” Client 2: ”Any design had to be done to standards that are approved by TOTAL as they are doing the designs all these documents needs to be signed off by our company engineers based on the relevant area of design the engineer will be chosen.” Client 3: ”We implement a robust change management process, conduct regular risk assessments, and we maintain a detailed documentation of design changes.”

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
15	To ensure that OHS clauses should be considered at the design stage without violating the related bylaws set by regulatory bodies for swift approval of design	Contractor 1: No comment pertaining this role Contractor 2: No comment pertaining this role	Contractor 1: ”Depending on the client some will have measures to ensure that designs don’t violate related bylaws. All the majors in oil and gas will have their own practices and we will be able to follow them” Contractor 2: ”At the design stage we usually get the procedures from the client, before we start the designs we are clear about this from a legal standpoint.”	Client 1: ”This depends on the contract, of course there are all kind of requirements on this but these requirements are managed by the design team and the legislation companies. Client 2: ”First and foremost the contractor must do their own checks to make sure they are not violating any bylaws but on top of that we will have a team of 3 safety officers, one who is more aware of legislation and will make sure we are in compliance”	Client 1: ”That is the responsibility of the Owner’s Engineer (Consultant), they have experts in their staff who are examining the design for example to dutch regulatory or international standards. Although we are at the front of the line this risk is transferred to the Owner’s Engineer contractually.” Client 2: ”There is a position within the project called a project risk manager who will be responsible for going through all local legislation and the TOTAL standards and we will design to whichever standard is higher standard. The risk manager will ensure our designs aren’t violating any legislation before sending it for approval from regulatory bodies.” Client 3: ”We as a client appoint consultants who shall review the project design packages and ensure the compliance of design parameters in line with regulatory requirements. The designs shall be developed in consistence to the building codes and thus swift approval will be received.”

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
16	To provide proper guidelines to design engineers for identifying and designing out the risks:	Contractor 1: "We have to take in consideration the general building standards, our own quality norms and of course work according to the Arbo law." Contractor 2: No comment pertaining to this role	Contractor 1: "In general it is written in the law, EU, local regulations. It is not voluntary. We have something called the gap analysis, which compares client requirements, our requirements, and legal requirements but this is more used in construction phase." Contractor 2: "It is crucial that the client establishes these guidelines because then it is clear and we can obtain all the necessary information from the client with the lack of that we can not be held responsible for any future variations. However, it is important to note that these guidelines are usually established by the contractor, employer or by local requirements."	Client 1: "We have complete guidelines on that, we have clear instructions on how to develop the designs. Client 2: "The design team must know the use and the life-cycle of the project and therefore it is important for them to consider the maintenance and operation in the design phase itself. We give guidelines more to create awareness for safety and to think beyond just the design phase."	Client 1: "We have a HSE Cultural Framework that is applicable worldwide that are the bylaws so to speak from shell but you need to develop your own HSE management system according to local conditions of the project so there is an overarching management system." Client 2: "This goes right back to the company standards, we have a very firm framework of how to identify safety risks (TRA), we look at that. The role of the design engineers from TOTAL is to take this into consideration." Client 3: No comment pertaining to this role.
17	To take every possible effort for identification of risks in design phase of project and categorize them on basis of their impact on stakeholders	Contractor 1: "I'm not too sure how clients involve their stakeholders but when it comes to us it is hard to involve our stakeholders when we don't know if we are selected or not." Contractor 2: No comment	Contractor 1: "The risks are indeed categorized based on their impact on stakeholders" Contractor 2: "In terms of identifying and distributing safety risks to different stakeholders the client expects us to take the lead role. This is because of the type of contracts that we do (EPCM) therefore we act as the manager."	Client 1: "Yeah basically for each step we have 11 or 12 safety topics, all of these topic which are valid for a project need to be considered and all relevant stakeholders are allotted these aspects." Client 2:	Client 1: "In the HAZID there is a column that addresses who is the stakeholder that is most impacted and who is responsible for addressing that risk." Client 2: No comment pertaining to this role Client 3: "In the context of safe design, several stakeholders play crucial roles in ensuring safety throughout the design process By involving all relevant parties, we can proactively address hazards and create designs that prioritize safety from the outset."

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
18	To frequently interact with all stakeholders for effective collaboration and conduct meetings with agenda of safety for realization of safe design	Contractor 1: "Depends on the kind of contract – if they make the design then we are not involved at all. If they want us to make the design then we are in charge and involve them at various times with updates and RIE (Risk Inventors and Evaluation) sessions." Contractor 2: No comment pertaining to this comment	njhghyigujyfhyh	Client 1: "That completely depends on the project, we have weekly, bi-weekly meetings with the design team." Client 2: No comment pertaining to this role	Client 1: "Depends on the stakeholder with the design team once a week with clear targets, project director bi-weekly, and on a monthly basis with the business operations manager and depending on the size and importance of the project it could as well with the CEO of shell once every 2 months. External stakeholders is depends on the maturity and the progress of the designs." Client 2: "The project team and the contractor that is almost hourly when we look at external stakeholders in terms of the regulator that is probably, depending on what's happening, monthly or quarterly." Client 3: No comment pertaining to this role

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
19	To share the knowledge related to risks and OHS to all stakeholders and review the design documents to ensure that risks are listed as identified.	Contractor 1: ”The client shares this through the health and safety design plan.” Contractor 2: No comment pertaining to this role	Contractor 1: No comment pertaining to this role Contractor 2: No comment pertaining to this role	Client 1: ”All this information will be available in the safety database and the health and safety plan.” Client 2: ”We would share our knowledge relate to risks and safety to stakeholders by conducting workshops and informal discussions.”	Client 1: ”Once every two weeks i do a presentation or an interactive workshop regarding one of the safety topics. Once a year there is a shell safety day so guidelines from the top of shell HSE dept and this year we want to have a focus on life saving rules, lifting and hoisting, etc.” Client 2: ”When we go out to tender we develop a basis to design document that allows us to share accurately how we formed the designs (preliminary), which will provide the foundation for the designs to be developed. Moreover there is complete transparency with the contractor and he will be provided all the information that we have obtained so far in the process.” Client 3: ”Project will have kick off meetings and pre boarding meeting to address all design issues, these platforms and internal communications are used to share the knowledge related to safety risks. As the project execution is in progress, there could be project progress meeting and in this meeting the safety risks can be also discussed, and decision can be made.”

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
20	To establish with all stakeholders, the practices required for risk assessment and record risks associated with every construction activity	Contractor 1: ”Sometimes we do have risk sessions with the client, but more often not than not the risk assessment process is done internally and then shared with the client for feedback.” Contractor 2:”We do use a project management plan and under that we got a lot of procedures, internal procedures, also procedures provided by the client.”	Contractor 1: ”Different clients establish different practices for risk assessment and recording but they are all subject to the same regulatory requirements.” Contractor 2: ”Because we are EPC contractors we are responsible for this not the client.”	Client 1: ”This is still something we are working on. At shell everybody needs to follow the procedures of shell, however, since we are a public institute it is difficult to demand that contractors use our risk assessment and recording practices.” Client 2: ”We mention to the contractor the requirements that there method of risk assessment and recording risks but it is their choice on what kind of specific system they use.”	Client 1: ”There are three scenarios here, Mode 1: the HSE Management System of the client is better we follow our practices; Mode 2:the HSE Management System of the contractor is better we follow their practices, Mode 3: the contract is executed off-site we don’t care in this scenario.” Client 2: ”We have our company policies that guide us and that is what we will adhere to and the contractor would expect to do the same. Although they can have their own safety management systems they will have to meet our company requirements.” Client 3: ”In such projects, stakeholders are required to meet certain contractual obligations and thus they must abide by risk assessment procedure and record keeping. The contractual terms and conditions are essential to ensure the stakeholders’ compliance in these aspects. As part of this, regular inspections and audit programs shall be conducted, and construction activity risk shall be recorded and followed up for its mitigation plans.”

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
21	To set higher bars for OHS through implementation of PtD and DfCS	Contractor 1: ”What is important is not only that you build safely, but also the phase after: can you maintain it safely. More than ever is that in the past we would have built something and then thought, right, good luck with that. And then when it comes to maintaining, for example, roofs, and there’s no way they can get to it. So it’s so that’s now more taken into consideration.” Contractor 2: ”Clients do insist on these concepts mainly because they are aware of the obligation to verify, which has come up in the legislation 4 years back and this is helping in making things better.”	Contractor 1: ”Although the client makes sure that we as design team apply these concepts the client needs to play a role in transferring this knowledge to the teams that will be executing the future stages of the project.” Contractor 2: No comment pertaining this role	Client 1: ”Although we expect this to be standard practice we see that health and safety specialists constantly needs to remind both our design team and the contractors design team that they need to take into account future construction stages.” Client 2: ”This is something we insist because It allows for a more efficient way of designing with the view for maintaining assets in the future.”	Client 1: ”It is the complete construction life-cycle that is considered during the design from inception to demolition.” Client 2: No comment pertaining to this role Client 3: ”During the design stage PtD and DCfS are concepts that we very much challenge the contractor with because it can contribute to safer designs and better outcomes for workers, users, and the environment.”

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
22	To ensure that design include OHS on the constructability, use and maintenance of the structures	Contractor 1: "It really depends on the knowledge of the client sometimes the client lacks the knowledge so then we would advice them. Sometimes the client does have the knowledge in which case we would follow his, often, strict specifications." Contractor 2: "I think this is very important to consider and it is essential for clients, especially in a long-term project like the one I am working on, to provide a safety portfolio that contains all the details about the maintenance of the assets so it can be considered into the designs."	Contractor 1: No comment pertaining to this role Contractor 2: "This really depends on the type of client and his experience but we do our part by questioning the client until we are clear of exactly what he expects from the project."	Client 1: "There can be real improvements on having health and safety specialists during the design phase to ensure that maintenance can be done in safe way. What we see is there is a strong focus on the construction phase. We seem to forget that the asset needs maintenance, since 2012 we have new legislation stating every new building you make you have to provide a list with info about how you will maintain the asset. I don't have the right words for this but ya more attention needs to be paid to this." Client 2: No comment pertaining to this role	Client 1:"It is the complete construction life-cycle that is considered during the design from inception to demolition." Client 2: "At this stage a suit of engineers from various disciplines will be on board to assist in the consideration of operation in the design." Client 3: "We ensure we have clear plans and specs to consider constructability, we consider maintainance such that there is ease of maintenance ensuring the project is efficient and safe throughout the life-cycle of the project."
23	To review with designers, all the proposed construction practices to avoid inheriting the risks	Contractor 1: No comment pertaining this role Contractor 2: No comment pertaining this role	Contractor 1: No comment pertaining this role Contractor 2: No comment pertaining this role	Client 1: No comment pertaining this role Client 2: No comment pertaining this role	Client 1: No comment pertaining this role Client 2: No comment pertaining this role Client 3: No comment pertaining this role

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
24	To make sure that designers must submit a hazard free design considering construction methods and site conditions To ensure that the design team must consider OHS issues as required by the nature and type of project and project oriented specific OHS measures.	Contractor 1: ”And then of course, we already say to the client that, for example, the ground we work on has to be of a certain quality that we’re not. If we put a crane there, it sort of sinks away. Again some clients are more aware and others need to be told.” Contractor 2: ”Not sufficiently enough. The client in my experience doesn’t take certain things into account in the early stages.”	Contractor 1: No comment pertaining this role Contractor 2: ”The client can ensure that safety issues specific to the nature of the project are considered by the design team if he shares all the relevant information he has. The client can ensure that site inspections are conducted by the design team and meetings can be conducted for any questions regarding the site conditions.”	Client 1: ”That is by ensuring that we have a health and safety specialist and we are now working on that. RWS is working on a policy decision that the health and safety specialist is on each team.” Client 2: ”We make sure this occurs by reviewing their plans and commenting on them and before the contract starts we conduct a lot of feasibility studies therefore we are well informed when accepting the designs that all site specific conditions are taken into account.”	Client 1: ”This is ensured by following the HAZID process” Client 2: ”As I had mentioned earlier we are transparent with our information, in fact the EPC contractors team will be equally if not more staffed on site. They will be able to gather more information than us.” Client 3: ”We do this by conducting a project specific risk assessment considering project scope, environment, materials, functionality, industry standards and regulation, lessons learn from similar projects, site-specific hazards, and user needs and behaviors.”

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
25	To involve OHS requirements in the tender documents to assess tenderer's knowledge about OHS matter	Contractor 1: "They can dictate that a HVK (Higher Safety Officer) or MVK (middle HSE) is involved in the team. But generally this is not stated but decided by ourselves depending on the complexity of the project. They generally state that it should adhere to current law and regulations. Contractor 2: "Mostly they try to look into the previous projects you have executed. Then they take into consideration other things like your communication with other stakeholders in the construction site, what measures you take to make sure no one gets hurt, etc."	Contractor 1: "Ya it varies per client some of them come down to the office for an audit, others just review your proposal, they ask questions and you provide answers based on which they can make a decision that meets their requirements" Contractor 2: No comment pertaining this role	Client 1: "We have a complete list of safety requirements which starts with the tendering documents. Every tender document must be reviewed by a HS specialist to ensure that all HS requirements are in the tender documents. This is what we have established in the last two years. Depending on the project details will be required in the health and safety plan. The health and safety plan is the contract on all things safety." Client 2: "During the tender process, especially on this project, we challenge the tenderers to come up with solutions to specific risks that we found difficult to mitigate and through this we can assess the tenderer's knowledge on safety."	Client 1: "We have an IOGP questionnaire which is sent out to all the parties within the tender and we have to answer it and we have a company that assesses these questionnaires." Client 2: "We will be asking for their group safety record so again like lost time injury frequency rate, major incidents they have had that will be part of the tender process and the bid. But we will also ask them to include in the bid how they will approach safety for the project, we will ask them to provide information about professional safety advisors, the number of them, the competence so to that detail. We will also ask them to demonstrate their safety management system and mini-systems(permit to work system, within that." Client 3: "We will look at the Health and Safety Policy and Management involvement, the training that the contractor plans to set out, their subcontractor management, etc."

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
26	To involve a special clause about safety performance in the tender documents	Contractor 1: "In terms of safety performance the client will want to know our incident frequency, or which step of the safety culture ladder you are on, whether we are VCA or ISO 9001/14001 certified" Contractor 2: "Safety performance in definitely addressed in the tender documents, what exactly they want varies from client to client"	Contractor 1: No direct quote pertinent to this role. Contractor 2: No direct quote pertinent to this role.	Client 1: "What we do in the tendering phase is we have a checklist detailing how we will evaluate the contractors safety plan." Client 2: "We give the contract requirements regarding the safety through the instructions to bid, ranging from general to specific. Most of the aspects are covered by the Dutch Law but as RWS we have 12 safety domains (tunnel safety, traffic safety, occupational safety, etc.) and make this more specific for the project and clearly indicate how the tenderer will be assessed in regards to safety."	Client 1: "All of this must be clear to the contractor before they get into the tender phase so what I did is I had personal conversations with the tender teams of contractors to ensure that they understand how long it really takes to ensure safe construction. I have this opportunity because we have a max of 5 companies which also allows them to visit and re-visit." Client 2: "Safety performance is addressed in the tender documents in quite some detail, the kpi's are put in there with a value against them. There is also a substantial financial incentive included in there along with heavy fines for failure to meet the requirements." Client 3: No direct quote pertinent to this role
27	To require from tenderer to produce OHS plan and the construction method details as a component of tender response file	Contractor 1: No direct quote pertinent to this role. Contractor 2: No direct quote pertinent to this role.	Contractor 1: No direct quote pertinent to this role. Contractor 2: No direct quote pertinent to this role.	Client 1: No direct quote pertinent to this role. Client 2: No direct quote pertinent to this role.	Client 1: No direct quote pertinent to this role. Client 2: No direct quote pertinent to this role. Client 3: No direct quote pertinent to this role.
28	To require an emergency plan to be included in the contractor's safety program.	Contractor 1: No direct quote pertinent to this role. Contractor 2: No direct quote pertinent to this role.	Contractor 1: No direct quote pertinent to this role. Contractor 2: No direct quote pertinent to this role.	Client 1: No direct quote pertinent to this role. Client 2: No direct quote pertinent to this role.	Client 1: No direct quote pertinent to this role. Client 2: No direct quote pertinent to this role. Client 3: No direct quote pertinent to this role.

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
29	To involve a clause in the tender documents explaining that non-compliance to OHS requirements as specified can lead to termination of the contract	Contractor 1: No direct quote pertinent to this role. Contractor 2: No direct quote pertinent to this role.	Contractor 1: No direct quote pertinent to this role. Contractor 2: No direct quote pertinent to this role.	Client 1: ”We can be more strict on this aspect, but for starters if they do not meet the requirements they cannot start work. At this stage its more an interaction with the contractor rather than saying hey this is not compliant, so we will give you a fine” Client 2: ”It is covered in the tender documents and the consequences could be different, firstly they need to register what they did and why they did it, in the case where a third party is involved in a safety issue then they could get a fine and we have a system for that in the contract. We would consider the fine but at the end we wouldn’t give it. It is not in the nature of the contractor to think about the safety clauses of the contract so our role is really to help them rather than give them penalties.”	Client 1: ”We do mention how non-compliance is dealt with but within shell we want to do the project together so the terms are mild you have to really f**k it up to be kicked-off the project. We recognize that there is huge HSE competency gap between the contractor and the client.” Client 2: ”During the tender phase we will have a scoring against our requirements and if someone is low on a particular category we will go back and tell them to work on that aspect. This scoring will also have a weightage aspect to it so we can assess how being non-compliant to one aspect may affect the safety performance of the overall project.” Client 3: No direct quote pertinent to this role

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
30	To involve an item of OHS in project cost estimate which is prepared by the consultants	Contractor 1: "On infrastructure project the costing of safety is not covered in too much detail but in oil and gas it is like a pre-work conditions, there has to be a certain IF and if you don't you have to explain it." Contractor 2: "Well, let's see it is covered in the BOQ but unfortunately there are no specific line items for safety but would be very sensible to do. This will allow a more direct and official way to contribute funds to safety and will make construction sites safer."	Contractor 1: "Depends, I ran into this a couple of times in some countries its compulsory to isolate safety in the project cost estimate and in other countries it is part of the big pile of information." Contractor 2: No direct quote pertinent to this role	Client 1: "That depends on the work, but in general there is a separate item for OHS but more so in the two-phase contract. However, it is important to note that this is not as detailed as in the O&G projects." Client 2: "When it comes to the detail in the BOQ safety is not covered. We do not ask for costs related to achieving safety outcomes."	Client 1: "Yes there is a separate item and is detailed much further into subdivisions for example how much for the permit issuer, how much for HSE Supervisor, how much cost for electrical expert, etc." Client 2: No direct quote pertinent to this role Client 3: "The minimum detail to which safety should be addressed in the costing is that it must include: PPE and Clothing, Safety equipment and gear, first aid kits and medical supplies, safety training and education, safety personnel and management."
31	To detail the item covering OHS matters and given due consideration as other items	Contractor 1: "Safety is not detailed like other items" Contractor 2: No direct quote pertinent to this role	Contractor 1: No direct quote pertinent to this role Contractor 2: "Safety is addressed to an equivalent degree if not more"	Client 1: "Not as detailed as the sections, its getting more important but we are coming from a time where we mainly focus on financial management. Its getting more even now." Client 2: "I believe for this project it was not that detailed it was an overview but as established by the new regulation to be more detailed things are changing."	Client 1: "Safety is addressed in extreme detail" Client 2: "Safety forms a core part of the contract, there is a lot of emphasis put on that and it is covered equally to the other elements." Client 3: No direct quote pertinent to this role
32	To promote awareness of OHS by attaching the OHS related legislation documents within the tender documents and to ensure the application and enforcement of such OHS laws	Contractor 1: No direct quote pertinent to this role Contractor 2: No direct quote pertinent to this role	Contractor 1: No direct quote pertinent to this role Contractor 2: No direct quote pertinent to this role	Client 1: No direct quote pertinent to this role Client 2: No direct quote pertinent to this role	Client 1: No direct quote pertinent to this role Client 2: No direct quote pertinent to this role Client 3: No direct quote pertinent to this role

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
33	To select safe contractors by evaluating expertise of contractor's project management team and safety staff, contractor's total recordable injury rate (TRIR) on past projects, and quality of his safety program.	Contractor 1: "It is crucial because it gives the client an indication of whether we work in a safe manner or not. Moreover, on projects now it is one of the first thing that clients look at." Contractor 2: "It plays a crucial role because those are the main criteria that clients use to select a contractor."	Contractor 1: "First and foremost these are factors that the client uses to select a contractor. Moreover, in the oil and gas industry they have something called the first point assessment limited and it is an industry wide data base where the client your safety information like your certification, procedures, achievements, etc. So companies like shell can tap into that data base and if you do not meet their scores they cannot accept you in their bidding process." Contractor 2: "It plays a really important role because it was the client uses to select us but we have great stats this usually doesn't affect our opportunities."	Client 1: "Yeah, this is the difficult part. It's something we would love to do as safety specialists but right now from our procurement rules we are not allowed to based on this information allowed to do base our decision. We can't select our contractors on safety performance." Client 2: "We expect contractors to show if they are working following our safety requirements that are addressed in our contracts. However, during the selection of the contractor it doesn't play a major role beyond the base standard. As RWS we don't ask for the safety culture ladder requirement but more and more we are trying to bring this in like how other clients do like pro-rail."	Client 1: "Not so much for me at least the contractor is chosen by visiting my counterpart in the contractors organization and have a discussion because there I understood that there is a clear difference in the tender people of a company who make the promises are not in contact with the other people in the project like the onsite workers who will actually execute the work." Client 2: No direct quote pertinent to this role. Client 3: No direct quote pertinent to this role.

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
34	To ensure that the project execution method must make room for financially stable contracting firm suitable for project and aware of OHS measures for projects	Contractor 1: ”Well, you always want to make sure that the contracts that you can start you can finish. That you want him to be financially stable because there’s nothing worse than one contractor not being able to finish, and then another one picking up where he left off. It always gets messy then.” Contractor 2: ”I think it is very crucial because an unstable company might not take all necessary measurements, you might take more risks than a stable contractor would do.”	Contractor 1: ”Depends on the type of contract, if it is reimbursable the client is paying for everything you buy for them so your stability is the stability of the client. But if it is lump sum you take a lot of risk, so if you are not stable enough you are forced to make the wrong choices.” Contractor 2: ”When you do go about hiring a financially stable contractor the expectation to maintain a safe environment is also higher. Of course if it is a financially stable contractor he might have better tools but in terms of competence there is no difference. You might have a Ferrari or a fiat panda but if you can’t drive it doesn’t make any difference. Could affect in terms of quantity but not quality.”	Client 1: ”I’m not sure there is a link the main issue i see with our work is that we go for large contracts because we want to avoid too many tenders meaning that all the work has to be done by contractors who might not be capable of doing so.” Client 2: ”It is really about the safety standards of the company but not the financially stability, as in of course the construction company shouldn’t be bankrupt. As RWS we also hire contractors from around Europe and the commitment to safety and the safety culture is different for different countries so it is important to select a safety conscious contractor rather than a rich contractor.”	Client 1: ”We only works with middle-high range contractors. There is a financial assessment sometimes the finance manager could conclude that the contractor may be close to bankruptcy and then we don’t go for them.” Client 2: ”Unfortunately we have a very strong policy for going for the cheapest contractor. Of course, they will be meeting the minimum criteria but we need to question whether we will benefit more from picking one who scores high and not just meet the min criteria.” Client 3: No direct quote pertinent to this role.

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
35	To consider a tenderer who has responded well to the clause on OHS matters during awarding process	Contractor 1: No direct quote pertinent to this role Contractor 2: ”We are ranked on a scale of 10 and we are told why we are given a particular score”	Contractor 1: ”Looking at all the questionnaires all of them are different some being 40pgs, the other 500 so I have no clue how they evaluate that. It is a secret. But when it is the authorities they have to follow procurement rules so it is more transparent so is the case with the oil and gas companies. But how do you measure the safety performance of a company (I don’t think there have been standards to assess that).” Contractor 2: ”Often this is done by the client through the review and assessment of the HSE Plan and if they are making a decision based on safety parameters they would select the contractor with the most stringent HSE plan.”	Client 1: ”There is a whole team working on that, hse guys will look at the safety part, the technical part will look at the technical aspects, etc.” Client 2: ”There is a tender team in RWS that assess this based on the questions they ask to the tenderer and the answers they give. However, this assessment is mostly made from a technical point of view and rarely from a safety perspective.”	Client 1: ”There is no method to assess this” Client 2: ”I mean other than the things I’ve already mentioned we look at the the ease of negotiation with them, the financial side, you know that that will all be weighted scoring as well.” Client 3: ”Tenderers are assessed based on their adherence to safety-related clauses outlined in the tender documents. This includes demonstrating understanding and commitment to safety processes and procedures.”

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
36	To bring in knowledge of tenderer, the OHS risks identified by design team	Contractor 1: ”Well, like I said, what you find is that there’s certain clients like Gasuni they know everything about how to transport gas in their pipes. I mean that’s their core business. But what you find is that they don’t know how to for example build any sort of civil works around that, so you find with clients like that, they don’t know enough about our core business and therefore should act as a sparring partner for us.” Contractor 2: ”The client does indeed ask our opinion on some of the challenges they identified in previous stages and keep that information to make informed decisions himself.”	Contractor 1: ”The client does at times involve the contractor early on to reflect on identified risks but every project is different so it really depends on the client. But with mature clients you do have good dialogue to understand and allocate risks.” Contractor 2: ”Well, because we are EPC contractors we are involved in the design phase so of course our knowledge in risk identification.”	Client 1: ”In the tender phase we will do 2 things: the first thing we will have a dialogue session, 2 or 3 will be done prior to tendering which will discuss the work and how we will review HS, during which they can share their remarks. What we see that is sometimes the contractor will use this to come up with additional costs.” Client 2: ”We do this by throwing a challenge and ask tenderers to come up with solutions”	Client 1: ”In the contract it is restated that the contractor is challenged to find issues in our HAZID and if they have a better idea about how manage a certain risk we will accept a new method. We have to accept that we don’t have all the knowledge. You have to always be open minded even if you know the contractors safety competence is lower than the client and can bring complete new opportunities for us.” Client 2: ”The contractor’s knowledge is not really involved in the tender phase, but all we would ask is about is a time and cost estimate.” Client 3: No direct quote pertinent to this role

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
37	To approve the resumes of key safety personnel submitted by the contractor	Contractor 1: "Sometimes the expectations of the safety personnel are clear from the client, for example from an oil and gas point of view they establish what type of safety representative should be present in the execution phase based on how many people are working on site. But this is the case mostly for oil and gas and not other types of projects." Contractor 2: It really depends on the type of project and client some just provide certain qualifications, other require CVs and some go as far as interviews and assessment to know what kind of person you are, whether you can take responsibilities and that kind of stuff.	Contractor 1: "The contractor has to share the CVs of the key safety personnel, sometimes they want to see typical CVs sometimes they want to know exactly who is working on the job. It varies per client, some clients don't want to CVs because they don't want HSE people on the job." Contractor 2: "The client would expect us to submit the CV's of our safety personnel and would expect no less than 10years of experience for safety managers and 5years for safety supervisors."	Client 1: "We would require safety staff depending on the project and we would need to the CV's of safety personnel." Client 2: No direct quote pertinent to this role	Client 1: No direct quote pertinent to this role Client 2: No direct quote pertinent to this role Client 3: No direct quote pertinent to this role
38	To make sure that principal contractor bidding for contract have provided capital for OHS measures and appoint only after being satisfied regarding his necessary competencies and resources	Contractor 1: No direct quote pertinent to this role Contractor 2: No direct quote pertinent to this role	Contractor 1: No direct quote pertinent to this role Contractor 2: No direct quote pertinent to this role	Client 1: No direct quote pertinent to this role Client 2: No direct quote pertinent to this role	Client 1: No direct quote pertinent to this role Client 2: No direct quote pertinent to this role Client 3: No direct quote pertinent to this role

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
39	To evaluate contractor by reviewing his commitment towards safety via site visits and interviews	Contractor 1: "More and more safety culture ladder is playing a key role" Contractor 2: No direct quote pertinent to this role	Contractor 1: "It starts off right at the pre-qualifications for the tender, the client will check the Competence of people, disciplinary actions, recognition programs, do you have certification or not (vca, iso), statistical performance from the last 3-5 years, how you manage risk, HSE plans, fluor has a small write up to send out to clients with this information." Contractor 2: "From the standpoint of assessing our commitment towards safety we in fact take the lead and inform the client what he can do better from a safety standpoint. Moreover, clients don't want to do more than they are already doing in terms of tendering therefore the usually select us."	Client 1: "Part of our obligation as a client is to ensure that the contractor is working according to the HSE plan. We will be on site on a regular basis starting once or twice a week, all high risk activities we will attend the kick off and see how they are working. Based on how the contractor is working we will increase or decrease our site visits." Client 2: "If they come up with smart safety solutions to the problems we have thrown at them it shows that they are committed to safety."	Client 1: "Before they go into execution we have the go/no-go criteria which is also part of the contract. We will conduct an audit based off this criteria which needs to be in place before you go into execution." Client 2: "Looking at their safety trends but it is difficult looking at it from outside, you don't really understand what is going on within the company. We hope that the contractors are transparent with us but of course there is an amount of tweaking of numbers that are involved. We would use the first point assessment as well to get this information from a neutral source." Client 3: "We look at their SMS, Risk Assessment Participation, Documentation and Communication, Contractor compliance and safety policies, incident history and safety record, training and competence, and monitoring and adjustment."
40	To establish minimum safety requirements in the contracts other than the legislation	Contractor 1: No direct quote pertinent to this role Contractor 2: No direct quote pertinent to this role	Contractor 1: No direct quote pertinent to this role Contractor 2: No direct quote pertinent to this role	Client 1: No direct quote pertinent to this role Client 2: No direct quote pertinent to this role	Client 1: No direct quote pertinent to this role Client 2: No direct quote pertinent to this role Client 3: No direct quote pertinent to this role

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
41	To make sure contractors include, in contract documents, safety program elements such as daily job safety analysis and subcontractor's safety inspection	Contractor 1: No direct quote pertinent to this role Contractor 2: No direct quote pertinent to this role	Contractor 1: No direct quote pertinent to this role Contractor 2: No direct quote pertinent to this role	Client 1: No direct quote pertinent to this role Client 2: No direct quote pertinent to this role	Client 1: No direct quote pertinent to this role Client 2: No direct quote pertinent to this role Client 3: No direct quote pertinent to this role

S/No	Client Roles as recognized by literature	Results- Contractors perspective : Infrastructure	Results- Contractors perspective : Oil and Gas	Results-Client Perspective : Infrastructure	Results-Client Perspective : Oil and Gas
42 & 43	42.To address OHS matters during contract negotiation 43.To clearly write in documents about OHS responsibilities of the parties to contract	Contractor 1: "We like to work for companies like Shell, for example, because they pay for safety. They would quite often choose the safer option despite it being the more expensive option." Contractor 2: "I don't think safety is considered enough but due to the change in the legislation there are some small changes happening but not enough. It comes back to the indicators that I had earlier mentioned. Sometimes we are fined if we can't jump up a level in the safety culture ladder within a year or two but that is not feasible."	Contractor 1: "HSE people are not commercial people so they have a difficulty in understanding but the funny thing is contracts are negotiated by academics, lawyers, and all kinds of smart people and none of them have the onsite experience so they negotiate a contract without knowing completely about site operations, which doesn't always lead to the development of suitable conditions that affect safety during construction. The contract doesn't reflect the proper responsibilities of the client and the contractor." Contractor 2: "The safety manager is always involved, following steps cannot happen if there is no approval from the safety department. The HSE signature is required for a contract to be signed. From the negotiation process we aim to reach a stage where the articles enlisted in the contract are in sync and comply with our safety expectations. For fluor the responsibility is clear and we make sure the contract is executed as articulated."	Client 1: "By the end of the contract negotiation process I would want ensure the contractor is aware of our role as a client, our requirements made in the health and safety plan, how to keep up with risk assessments, etc. However, in my experience, the problem is that the team that has done the bidding process is not the same as the execution team, new companies may be involved who may not follow the plans that have taken a long time to prepare." Client 2: "From my point of view in the tender phase safety was not really part of the dialogue. But what you see now within RWS is that they want to give that a bigger role in the tender phase, there are programs for that. With the conclusion of the contract both us and the contractor are clear on our responsibilities."	Client 1: "I go to the contractor and sit with their team and at the end of this process we expect the safety responsibilities for each party to be clear but in the execution we see that the foreman of the project are a different breed and the more we go to the workforce the less they know about the safety plans that there higher management is making." Client 2: "Safety would be involved. At the end of the process there shouldn't be any doubt at all. Everything should be very much. And I say that you'll as things develop and people, you know things start happening on the grounds then then things may change slightly but generally everything should be pinned down before you before you start." Client 3: No direct quote pertinent to this role